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THE PLANT ECOLOGY OF THE ISIPINGO BEACH AREA, NATAL, SOUTH AFRICA

CECIL JAMES WARD

BOTANICAL RESEARCH INSTITUTE ● DEPARTMENT OF AGRICULTURE AND FISHERIES ● REPUBLIC OF SOUTH AFRICA
NAVORSINGSINSTITUUT VIR PLANTKUNDE ● DEPARTEMENT VAN LANDBOU EN VISSERYE ● REPUBLIEK VAN SUID-AFRIKA

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THE PLANT ECOLOGY

OF THE

ISIPINGO BEACH AREA, NATAL, SOUTH AFRICA

WITH 59 FIGURES, BEING A THESIS SUBMITTED IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE OF M.Sc. IN THE DEPARTMENT OF BOTANY, UNIVERSITY OF NATAL

by

CECIL JAMES WARD

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1980

Foreword

It is well known that as a result of the acceleration in the growth of technology and populations, natural or even semi-natural environments are a steadily diminishing resource. This situation has prompted various environmentally concerned international organizations, including the International Botanical Congress held in Leningrad in 1975, to urge governments to conserve as much of our natural environment as possible, and also to make funds available as a matter of priority for the study of those environments which, for various reasons, are likely to disappear in the future. Agricultural, urban, recreational, farming and industrial development which has already taken a great toll of the Natal coastal vegetation was recently joined by a mining of dune sands for minerals, a serious additional threat. It was therefore fortunate that some work had been done and experience gained, when the obvious questions of the advisability of mining such a fragile habitat arose.

This pioneer work was undertaken by Mr Ward in 1949 and 1950 and subsequently revised and supplemented. It represents a meticulous and in-depth study of a small but varied area consisting of coast and dune forest as well as mangrove communities and other swamp communities at Isipingo Beach on the Natal South Coast. Since much of this vegetation has subsequently been destroyed, this study has a value beyond that of accounts of existing vegetation which may be restudied at any time and in this respect the study is probably unique for Southern Africa.

This detailed ecological investigation was undertaken in the classical Clementsian manner and contains a wealth of information ranging much wider than that of a simple account of the plants and animals occurring in the area, delving as it does into the dynamics of the ever-changing scene on the dunes and in the estuaries. In spite of the views of many modern authorities who tend to decry the theories developed in connection with plant succession by the classical schools, it is nevertheless true that much knowledge, indispensable to the scientific management of natural or semi-natural vegetation (which is destined to become a basic tool in the conservation and re-establishment of botanical resources), does accrue from such studies.

This contribution to our knowledge of the coastal vegetation of Natal is a first step. The work is being continued by, amongst others, a member of staff of this Institute. Thus it is hoped that an objective assessment of the relative values of the profits which will accrue from mining and the recreational and inherent worth of the coastal vegetation will eventually be possible.

In the long term, the knowledge gained by ecological research of this nature will no doubt contribute to the management of vegetation in a relatively stable state, as well as to the re-establishment of vegetation after exploitation.

B. DE WINTER
Director: Botanical Research Institute

Pretoria
9 June 1976

Contents

Page

FOREWORD iii
ABSTRACT 1
UITTREKSEL 1
RÉSUMÉ 1
INTRODUCTION 2
CHAPTER 1. PHYSIOGRAPHY 3
  1.1 LOCALITY 3
  1.2 PLACE NAMES 4
  1.3 TOPOGRAPHY 4
  1.4 GEOLOGY AND SOILS 6
CHAPTER 2. CLIMATE 8
  2.1 INSOLATION 8
  2.2 TEMPERATURE 9
  2.3 WIND 10
  2.4 PRECIPITATION 15
    2.4.1 Rainfall 15
    2.4.2 Thunderstorms 16
    2.4.3 Fog and mist 17
    2.4.4 Dew 17
    2.4.5 Hail 17
  2.5 RELATIVE HUMIDITY 17
CHAPTER 3. HISTORICAL BACKGROUND 18
CHAPTER 4. VEGETATION 21
  4.1 LITHOSERE 21
    4.1.1 Non-vascular plant communities 23
      4.1.1.1 Algae 23
      4.1.1.2 Lichens 23
    4.1.2 Vascular plant communities 24
    4.1.3 Interrelationships of supralittoral rock plant communities 28
  4.2 PSAMMOSERE 28
    4.2.1 White sands (modern dunes) 28
      4.2.1.1 Prisere 29
        4.2.1.1.1 Pioneer strand communities 30
        4.2.1.1.2 Open Dune Scrub 31
        4.2.1.1.3 Closed Dune Scrub 32
        4.2.1.1.4 *Mimusops caffra* Woodland 32
        4.2.1.1.5 Dune Forest 32
          (A) Transitional zone 33
          (B) Forest proper 33
      4.2.1.2 Subseres 36
        4.2.1.2.1 Disturbed seaward dune communities 36
        4.2.1.2.2 Disturbed closed communities 38
          4.2.1.2.2.1 Restricted disturbance 38
          4.2.1.2.2.2 Widespread disturbance 38
            (A) Miscellaneous clearing 38
            (B) Succession on disused golf course (grassland succession) 38
      4.2.1.3 Community interrelations 41
    4.2.2 Red sands (main hills) 42
      4.2.2.1 Salt-spray communities 43
        4.2.2.1.1 Priseres 43
          4.2.2.1.1.1 Pioneer and early scrub communities 43

(A) Slopes directly above modern beach sands ... 43
(B) Steep unstable slopes ... 44
(C) Stable slopes above supralittoral rocks ... 45
4.2.2.1.1.2 *Strelitzia* - *Brachylaena* Scrub ... 47
4.2.2.1.1.3 Closed Maritime Scrub ... 47
4.2.2.1.1.4 *Mimusops caffra* Transitional Forest ... 48
4.2.2.1.2 Subseres ... 50
4.2.2.1.3 Community interrelations ... 52
4.2.2.2 Non-salt-spray communities ... 53
4.2.2.2.1 Plant communities on moist slopes ... 53
4.2.2.2.1.1 Pioneer and herb communities ... 53
4.2.2.2.1.2 Scrub communities ... 54
4.2.2.2.1.3 Woodland and early forest communities ... 55
4.2.2.2.2 Plant communities on dry slopes ... 56
4.2.2.2.2.1 Pioneer and herb communities ... 56
4.2.2.2.2.2 Scrub communities ... 57
4.2.2.2.2.3 Woodland communities ... 58
4.2.2.2.3. Subseres ... 59
4.2.2.2.4. Community interrelations ... 59
4.3 HALOSERE ... 61
4.3.1 Communities in permanent water ... 63
4.3.2 Intertidal communities ... 63
4.3.2.1 Algal communities ... 63
4.3.2.2 Herbaceous vascular plant communities ... 63
4.3.2.2.1 Pioneer communities ... 63
4.3.2.2.2 *Phragmites australis* Brack-water Consocies ... 64
4.3.2.2.3 *Sporobolus virginicus* - *Paspalum vaginatum* Grassland ... 65
4.3.2.2.4 *Juncus kraussii* Communities ... 66
4.3.2.2.5 *Acrostichum aureum* Consocies ... 66
4.3.2.2.6. *Diplachne fusca* Consocies ... 66
4.3.2.2.7 Ephemeral upper-intertidal communities ... 67
4.3.2.2.8 *Stenotaphrum secundatum* Grassland ... 67
4.3.2.3 Woody plant communities ... 67
4.3.2.3.1 Mangroves ... 67
4.3.2.3.1.1 Pioneer mangrove communities ... 68
4.3.2.3.1.2 Mangrove scrub and early woodland communities ... 72
4.3.2.3.1.3 Mature mangrove communities ... 74
4.3.2.3.2 *Hibiscus tiliaceus* Communities ... 74
4.3.3 Community interrelations ... 74
4.4 HYDROSERE ... 76
4.4.1 Pioneer and early herbaceous communities ... 77
4.4.1.1 Communities in small streams and depressions ... 77
4.4.1.1.1 Submerged hydrophytes ... 77
4.4.1.1.2 Floating hydrophytes ... 77
4.4.1.1.3 Semi-floating hydrophytes ... 79
4.4.1.1.4 Emergent anchored hydrophytes ... 79
4.4.1.2 Communities in main river courses ... 79
4.4.2 Reedswamp communities ... 81
4.4.3 Streambank herb communities ... 82
4.4.4 *Phragmites mauritianus* Communities ... 82
4.4.5 Low-lying grassland communities ... 83
4.4.6 Low-lying scrub communities ... 86
4.4.7 Low-lying woodland and early forest communities ... 88
4.4.8 Subseres ... 90
4.4.9 Community interrelations ... 92
4.5 COAST FOREST ... 92
CHAPTER 5. BIOTIC FACTORS ... 95
5.1 PLANTS ... 95
5.1.1 Fungal parasites ... 95
5.1.2 Heterotrophic vascular plants ... 95

5.2 ANIMALS 95
  5.2.1 Mollusca 95
  5.2.2. Arthropoda 96
    5.2.2.1 Crustaceae 96
    5.2.2.2 Insecta 96
      5.2.2.2.1 Orthoptera 96
      5.2.2.2.2 Thysanoptera 96
      5.2.2.2.3 Hemiptera 96
      5.2.2.2.4 Lepidoptera 96
      5.2.2.2.5 Coleoptera 97
      5.2.2.2.6 Hymenoptera 97
      5.2.2.2.7 Diptera 98
  5.2.3 Vertebrata 99
    5.2.3.1 Birds 99
    5.2.3.2 Mammals, other than man 100
      5.2.3.2.1 Chiroptera 100
      5.2.3.2.2 Primates 100
      5.2.3.2.3 Carnivora 100
      5.2.3.2.4 Proboscoidea 101
      5.2.3.2.5 Artiodactyla 101
      5.2.3.2.6 Rodentia 101
    5.2.3.3 Man 101
      5.2.3.3.1 Utilization of native and naturalized plants 101
        5.2.3.3.1.1 Plants used medicinally or in witchcraft 102
        5.2.3.3.1.2 Food plants 102
        5.2.3.3.1.3 Plants used in building and fencing 102
        5.2.3.3.1.4 Plants used for cord 102
        5.2.3.3.1.5 Miscellaneous uses 102
5.3 FIRE 103
CHAPTER 6. ANNOTATED CHECK-LIST OF VASCULAR PLANTS FROM THE ISIPINGO BEACH AREA 105
SUMMARY 146
REFERENCES 147

Figures 3 (place names and major changes 1937-1968), 4 (geological and topographical features) and 59 (vegetation map) in pocket inside back cover

Abstract

Major environmental factors are discussed with reference to their effect on the vegetation as a whole. Those of local significance are correlated with the different plant communities and their interrelations in the relevant sections.

The inferred climatic climax, Coast Forest, is not reached in various parts because of the presence of salt-spray, adverse edaphic factors or the direct and indirect effect of man. In mesic situations where there has been long respite from burning or other interference by man, Coast Forest is becoming established; as yet, this is represented by only relatively immature communities. On certain steep slopes where biotic disturbance is minimal, the plant communities are more mature; these are considered to be, in the main, lociations of Coast Forest.

The general succession in the seaward parts leads to a woodland or early forest with *Mimusops caffra* as dominant or co-dominant. Where salt-spray ceases to be an important environmental factor and in mature closed forest, *M. caffra* is no longer an important constituent and the dominant trees under these conditions include among others, *Celtis africana, Chaetachme aristata, Cussonia sphaerocephala, Euclea natalensis, Podocarpus latifolius, Sideroxylon inerme, Strychnos decussata, S. madagascariensis* and *Ziziphus mucronata.* In wet, non-brackish areas, the succession is essentially from herbaceous hydrophytes to *Phragmites australis* swamp where drainage is poor, or, where drainage is better, generally via grassland with *Phragmites mauritianus* to low-lying mesic forest precursors and then mixed forest comprising *Trichilia dregeana, Ekebergia capensis, Protorhus longifolia* and *Rhus chirindensis* forma *legatii* and other species. Mangrove vegetation (*Avicennia marina, Bruguiera gymnorrhiza* and *Rhizophora mucronata*) and grasslands are described. An annotated check-list of vascular plants is included. The work is illustrated by 59 figures.

Uittreksel

Belangrike omgewingsfaktore word bespreek met verwysing na hulle uitwerking op die plantegroei as geheel. Die wat plaaslik van betekenis is, word in verband gebring met die verskillende plantgemeenskappe en hulle interverhoudinge in die toepaslike seksies.

Die vermoedelike klimatiese klimaks, Kuswoude, word in verskeie dele nie bereik nie as gevolg van die aanwesigheid van soutsprei, ongunstige grondfaktore en die direkte en indirekte invloed van die mens. In klam toestande waar daar in 'n lang tyd nie gebrand is nie of waar daar nie ander invloede van die mens is nie, ontstaan Kuswoude wat tans slegs in relatief onvolgroeide gemeenskappe verteenwoordig word. Op sekere steil hellings waar biotiese steurings minimaal is, is die plantgemeenskappe meer volgroeid - hoofsaaklik lokiasies van Kuswoude.

Die algemene plantsuksessie in die dele naby die see, gee aanleiding tot 'n boswêreld, of jong woud, waar Mimusops caffra *dominant of kodominant is. Waar soutsprei nie langer 'n belangrike omgewingsfaktor is nie en in volgroeide geslote woude,* M. caffra *nie meer 'n belangrike bestanddeel is nie, sluit die dominante bome onder meer in,* Celtis africana, Chaetachme aristata, Cussonia sphaerocephala, Euclea natalensis, Podocarpus latifolius, Sideroxylon inerme, Strychnos decussata, S. madagascariensis *en* Ziziphus mucronata. *In klam gebiede waar die grond nie brak is nie, is die plantsuksessie hoofsaaklik van kruidagtige waterplante na* Phragmites australis*-moeras; waar die dreinering swak is, of waar die dreinering beter is gewoonlik as gevolg van grasvelde saam met* Phragmites mauritanus, *na laagliggende klam woude wat* Trichilia dregeana, Ekebergia capensis, Protorhus longifolia, Rhus chiridensis *forma* legatii *en ander spesies insluit. Manglietplantegroei (*Avicennia marina, Bruguiera gymnorrhiza *en* Rhizophora mucronata*) en grasvelde word beskryf. 'n Verklarende oorsiglys van vaatryke plante word ingesluit. Die werk word geïllustreer met 59 figure.*

Résumé

ÉCOLOGIE VÉGÉTALE DE LA RÉGION D'ISIPINGO BEACH
(AFRIQUE DU SUD: NATAL)

On discute les principaux facteurs de milieu en tant qu'ils ont un effet sur la végétation dans son ensemble. Ceux qui n'ont qu'une signification locale sont mis en corrélation avec les diverses associations végétales et avec leurs interrelations dans les sections appropriées.

En divers endroits le climax climatique théorique, soit la forêt côtière, n'est pas réalisé par suite de la présence d'embruns salins, de facteurs édaphiques défavorables ou des effets directs et indirects de l'activité humaine. Dans des situations mésiques qui sont restées longtemps à l'abri du feu ou d'autres interférences humaines, la forêt côtière est en train de s'établir; jusqu'ici cependant elle n'est représentée que par des associations relativement immatures. Sur certaines pentes raides à perturbations biotiques minimales, les associations végétals sont plus proches de la maturité; on les considère principalement comme des lociations de la forêt côtière.

La succession générale des parties orientées vers la mer mène à un bois ou à une forêt précoce avec dominance ou co-dominance de Mimusops caffra. *Là où les embruns salins cessent d'être un facteur de milieu important et dans des forêts matures, closes,* M. caffra *cesse d'être un constituant important, les arbres dominants dans ces conditions incluent entre autres* Celtis africana, Chaetachme aristata, Cussonia sphaerocephala, Euclea natalensis, Podocarpus latifolius, Sideroxylon inerme, Strychnos decussata, S. madagascariensis *et* Ziziphus mucronata. *Dans les régions humides non-saumâtres la succession s'opère essentiellement depuis des hydrophytes herbacés jusqu'à des marais à* Phragmites australis *là où le drainage est pauvre; quand il est meilleur, la succession passe généralement par des prairies à* Phragmites mauritianus, *puis des précurseurs à port peu élevé de forêt mésique et ensuite de la forêt mixte comprenant* Trichilia dregeana, Ekebergia capensis, Protorhus longifolia *et* Rhus chirindensis *forma* legatii *et d'autres espèces. On décrit la végétation de la mangrove (*Avicennia marina, Bruguiera gymnorrhiza *et* Rhizophora mucronata*) ainsi que celle des prairies. Une liste de contrôle annotée des plantes vasculaires est jointe au présent travail qu'illustrent 59 figures.*

Introduction

This project was originally undertaken in 1949 and 1950. After a long period of the author's absence from the area, the work was revised and supplemented with additional data. Climatic data which were extracted from unpublished records made at the Louis Botha Weather Office have replaced the earlier data from more distant stations. The Louis Botha Weather Office, started in 1956, is only 1,5 km from the northern boundary of the study area. The distribution of plant communities has been brought up to date and lines of succession, following changes in the environment subsequent to the original work, have been included. In view of the destruction of the vegetation on the white sand dunes of Isipingo North, during 1969, the main vegetation map (Fig. 59) reflects conditions as they occurred in December 1968.

Liberal use has been made of photographs (some dating back to the end of the last century) and early written records to supplement data collected personally in the field. Aerial photographs, some taken by the author, but, more particularly, those of seventeen separate series taken for land-survey purposes since 1931, have been of particular value in this study. Although some of these photographs are of relatively small scale, the majority show the vegetation and topography in detail, e.g. Fig. 30. In an attempt to illustrate the dynamic nature of the vegetation and the changes in general environmental features, comparative photographs have been included, as for example in Fig. 2 which incorporates aerial photographs taken at approximately 16-year intervals. Except where these have been individually acknowledged, the photographs included were taken by the author.

When it was suggested that biological and phenological data should be added to the annotations of the revised check-list, it was decided that a final effort should be made to collect as many species as possible from this area so that the amended check-list should be as complete as possible. This was because industrial expansion was destroying much of the former vegetation and, for that matter, was altering both the topography and surface soils of certain parts.

The vast majority of the plants and animals have been identified by the author who accepts full responsibility for the determinations while, at the same time, acknowledging the very kind and valuable assistance given him by those mentioned below.

Grateful appreciation is expressed to the C.S.I.R. for a bursary which enabled this investigation to be initiated and to Professor A.W. Bayer for his guidance and willing help which included taking some of the earlier photographs. Sincere appreciation for the considerable assistance given in the identification of plant specimens is expressed to the Director of the Botanical Research Institute and his staff at Pretoria and at the Natal Herbarium, likewise to Drs M.A. Pocock, F.M. Getliffe and O.M. Hilliard and to Professors E.A. Schelpe and K.D. Gordon-Gray; the last named is also thanked for much helpful advice so kindly given in the course of this investigation. In addition, it is desired to record gratitude to the following: Dr B.R. Stuckenberg, for advice regarding insect identification and for naming some of the flies; the Harbour Engineer, Durban, and his staff for tidal data; the Director of the Weather Bureau and the staff of the Meteorological Station at Louis Botha Airport for their kind co-operation; the late Mr G. Ogle for providing rainfall records from the former Reunion Sugar Estates; Messrs Wall, Marriott, Paul and Borgen and field personnel of Aircraft Operating Company for the gift or loan of aerial photographs and for survey data; the late Mr Lynn Acutt and the South African Railways and Harbours for permission to copy photographs taken by them; the S.A.D.F. for permission to use the 1937 and 1953 Trigonometrical Survey Office aerial photographs; the Librarian in charge of the Don Reference Library, Durban, for facilitating historical investigation; Mr Vorwerk, Surveyor General's Office Pietermaritzburg, and Mr A.D. Manicom, City Engineer's Office Durban, for their willing co-operation relating to early records; Messrs O.J. van Staden and M.J. McCarthy of the Geology Department, University of Natal, for helpful discussions; the Natal Parks Board for permission to use data collected when the author was in their employment; Messrs S. Kasavan and D. Ramchurren for assisting with mounting and printing of some of the photographs; Professor O.A.M. Lewis, Dr J.Y. Grossert and the Council of the University of Durban-Westville for their kind co-operation and use of facilities. The willing assistance offered by various friends, colleagues and members of his family, in the form of general encouragement, the loan or gift of photographs, the recalling of earlier events, and the direct gathering of field data is most gratefully acknowledged by the author: direct assistance is acknowledged in the relevant sections. Finally he is deeply grateful to his wife and Mr G.W. Marshall for their additional co-operation in helping to check the typescript and, in particular, to Mrs G.W. Marshall for her kind and untiring assistance in the very onerous task of typing this work.

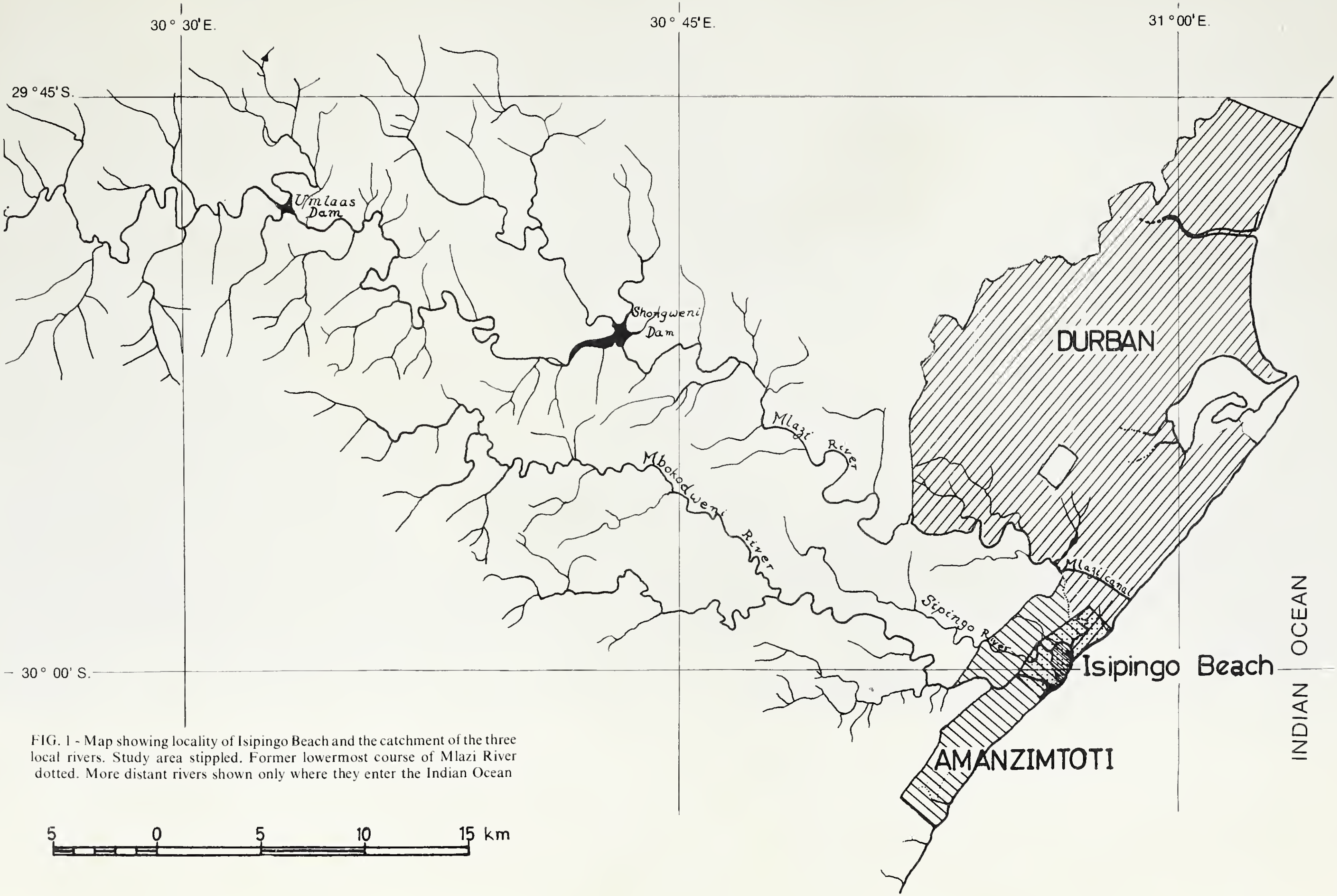
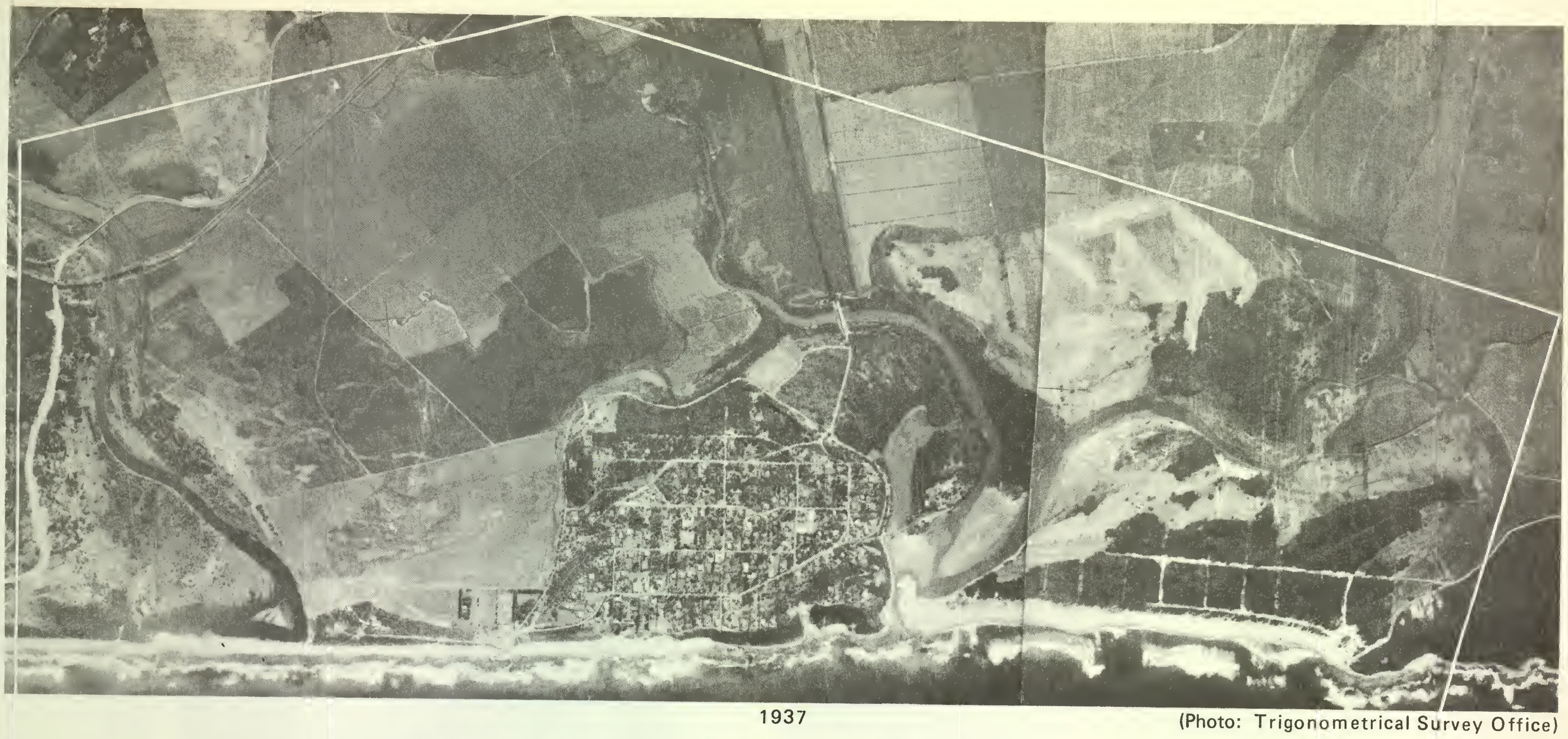
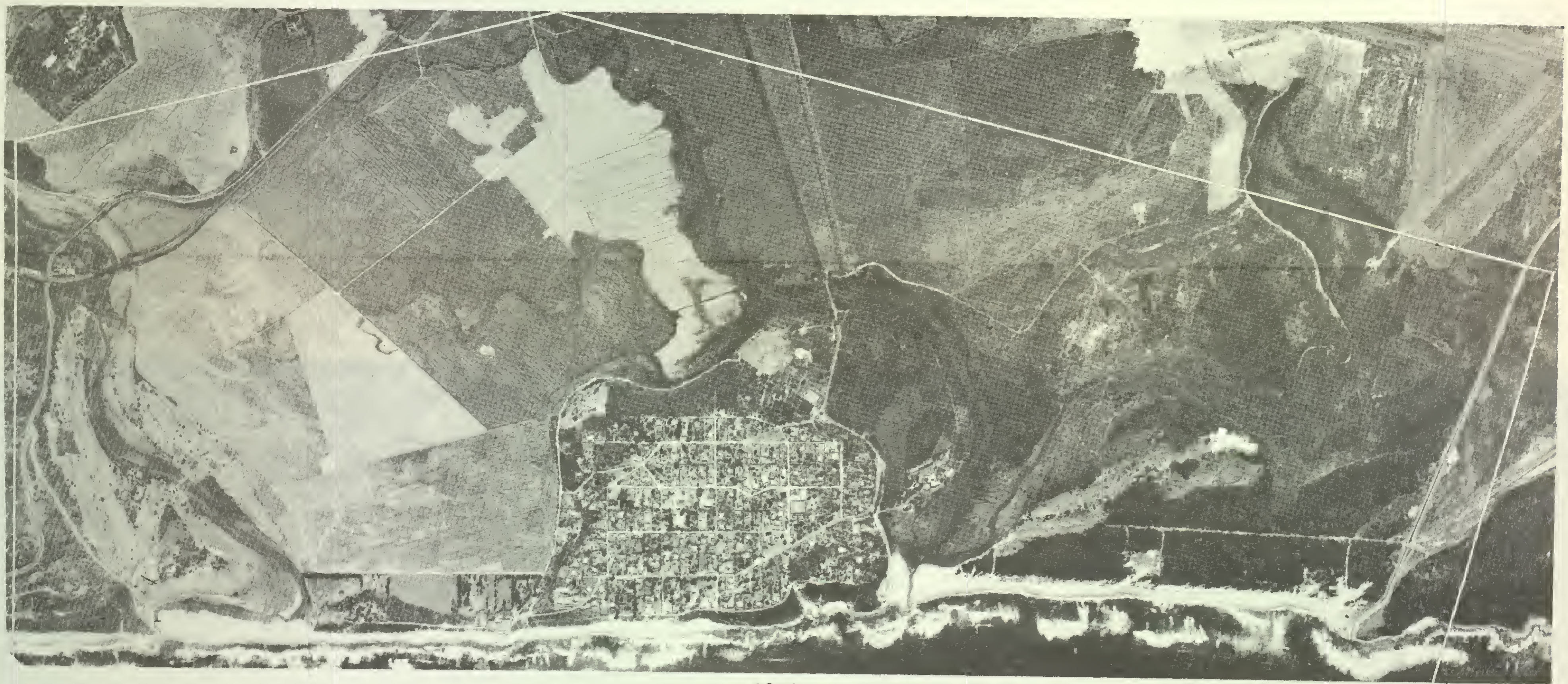


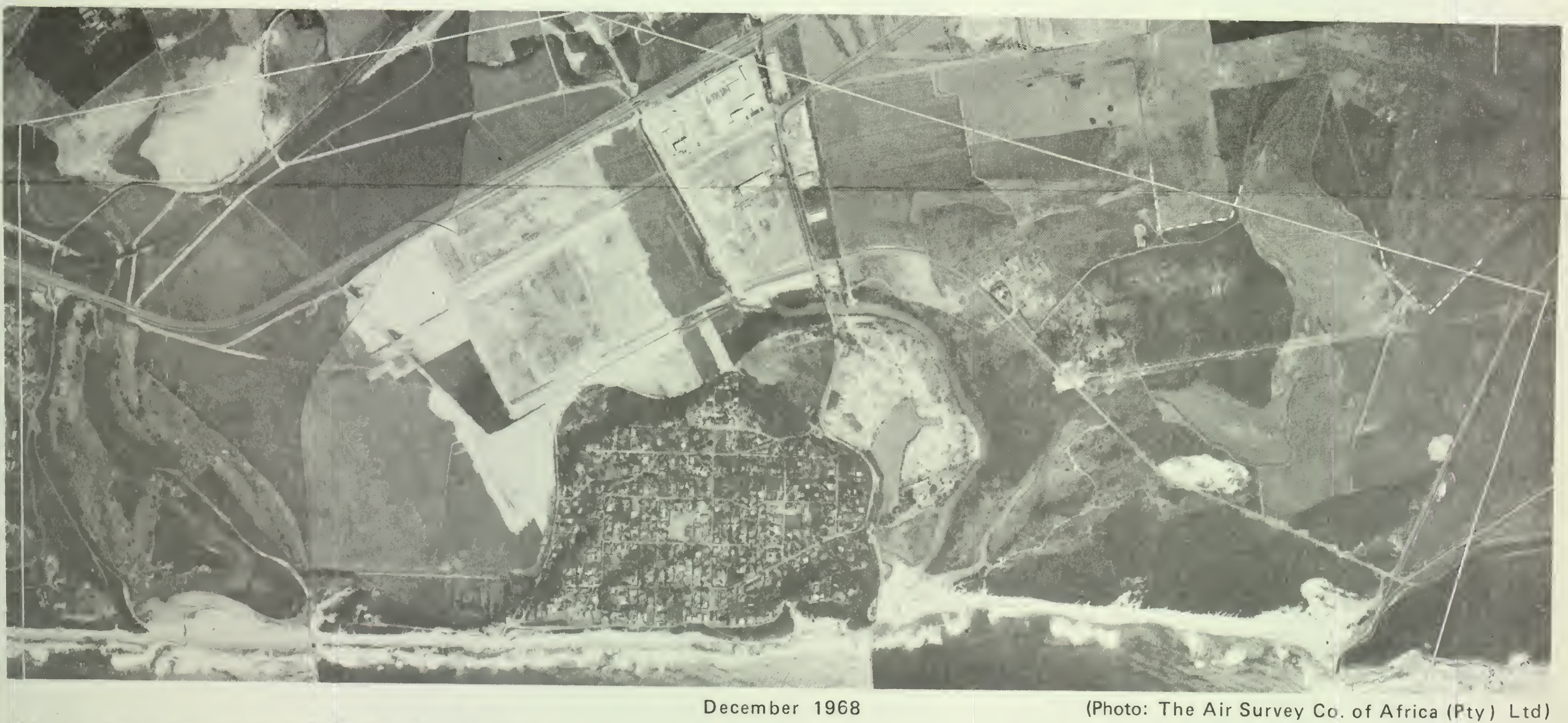
FIG. 1 - Map showing locality of Isipingo Beach and the catchment of the three local rivers. Study area stippled. Former lowermost course of Mlazi River dotted. More distant rivers shown only where they enter the Indian Ocean



1937 (Photo: Trigonometrical Survey Office)



1953 (Photo: Trigonometrical Survey Office)



December 1968 (Photo: The Air Survey Co. of Africa (Pty) Ltd)

FIG. 2 - Aerial views of the Isipingo Beach area, Natal
Study area denoted by white lines and, in 1968 photograph, by fenced boundary (broken line) of Louis Botha Airport
See Figs 3 and 4 for place names and other data

Physiography

1.1 LOCALITY

The study area is on the Indian Ocean shore of Natal and is centred on the residential area of Isipingo Beach (Lat. 30 °S). It extends southwards along the coast to the slopes of the hill immediately south of the Mbokodweni River and northwards to the slopes of the hill called Donsagolo which is a

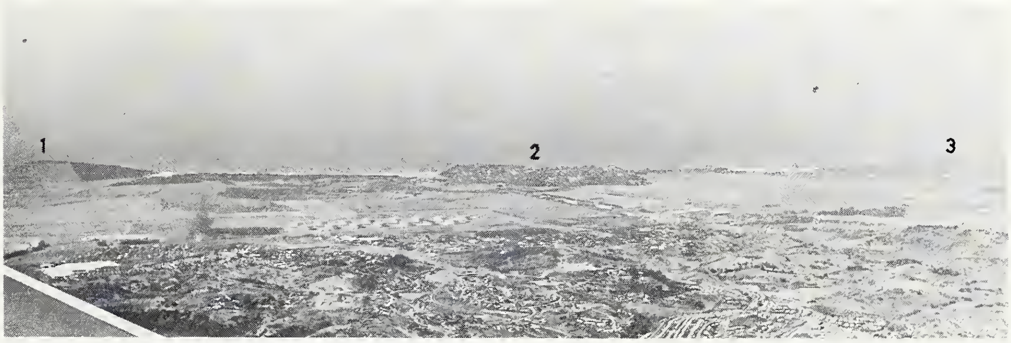


FIG. 5 - Aerial view of Isipingo Beach and environs, from north-west. 1. Donsagolo 2. Isipingo Beach 3. Athlone Park

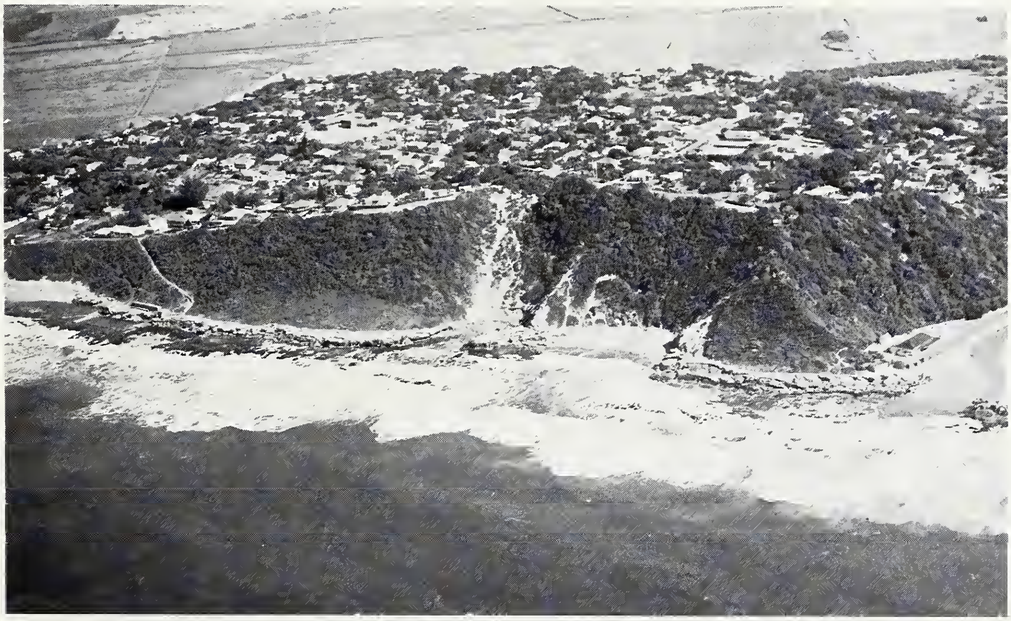


FIG. 6 - Isipingo Beach Hill from east, at low tide. Supralittoral rocks collapsed on seaward side, with vertical to overhanging faces. Where rocks breached, bays formed and hill-slope collapsed. Dwarf salt-spray zone clearly shown towards base of hill in left foreground. Modern beach sands banked up against older hill in extreme left foreground. Isipingo Flats, in background, being infilled with material from Jeffels' Hill, in distant left

southern extension of the Durban Bluff, giving a shore-line length of 4,8 km. Inland, it extends for a maximum distance of just over 2 km to include the uppermost limit of tidal influence in the Sipingo River. In all, it incorporates 873 hectares (Figs 1 and 2).

1.2 PLACE NAMES

Names of places and geographical features mentioned herein are those used by the Trigonometrical Survey Office (in particular as used on the 1960 edition of South Africa: 1:50,000 Sheet 2930 DD and 2931 CC Durban) with one difference in spelling, namely Mbokodweni rather than Mbokodeni. These are supplemented by locally used names (Fig. 3).

1.3 TOPOGRAPHY

As may be seen in Figs 2-6, the study area covers a series of seaward hills or ridges westward of which is a low flat plain traversed by rivers and drains which enter the sea on either side of the Isipingo Beach residential area, as well as one drainage canal, constructed in 1946, which opens into the sea at Reunion Rocks. Westward and southwards of this plain (the Isipingo Flats) is a further series of hills which only in part fall into the study area.

The central Isipingo Beach hill rises to 66,75 m at its highest point which is the apex of a precipitous slope dropping on to the beach. The south-western boundary reaches an altitude of approx. 76 m on the slopes of the Athlone Park hill, the beacon at the top of which is 112,8 m above sea level, while the north-eastern boundary extends to a similar height up Donsagolo, the summit of which is 100,9 m above sea level. The western corner of the study area is at an altitude of approx. 53 m on the southern slopes of Jeffels' Hill, the top of which is 65 m above sea level. Prior to soil removal (in 1963), an eastern knoll of this hill within the study area rose to 61,5 m (Figs 3 and 4).

The western flats vary from parts exposed only at low tide to others lying approximately 6 m above sea level. Here, due to the activities of man, there have been considerable alterations in the topographical profiles, particularly in recent years. In 1940/41 levelling of a portion of the flats for use as a military aerodrome was carried out. Starting in 1946, a considerable amount of infilling took place for the Louis Botha Airport which, however, lies mainly outside the study area. In 1965, an area between the Sipingo lagoon and the main access road to Isipingo Beach, formerly occupied by mangroves and low-lying woodland and scrub, was infilled. From 1966 until the time of writing, the main flats have been infilled to a height of approx. 3,5 m above sea level, the soil for this being brought from Jeffels' Hill. The Isipingo North dunes are currently being levelled and the adjacent flats infilled. This work started in 1969.

Of the two rivers which enter the sea in the study area, the Mbokodweni is the larger with a catchment area of 256,4 km^2. This rises in the Eston area, approximately 33 km south-east of Pietermaritzburg. Within the study area it is a relatively straight stream with no permanent tributaries. The other river, the Sipingo, rises near Inwabi approximately 16 km in a north-westerly direction from its mouth, and has a catchment of 46,6 km^2. Within the study area it is longer than the Mbokodweni and, with its tributaries mostly canalized nowadays, drains the greater portion of the Isipingo Flats.

The drainage pattern of the north-eastern section of the study area was radically changed in 1946 when a drainage canal was opened to the sea at Reunion Rocks and a sand dyke was thrown across an ancient course of the Mlazi River which, in this century, served to drain the extensive eastern portion of the Flats which was mostly under *Phragmites australis*. Prior to this, this water flowed into the modern Mlazi River which, in those days, joined with the Sipingo to enter the sea at the present mouth of the Sipingo River.

Although the Mlazi River was diverted in 1952, so that it now enters the sea approx. 4 km to the north of its former mouth, it has played such a significant part in flooding, in depositing alluvium and in influencing much of the vegetation and topography of the area, that it is briefly mentioned here. This river rises in the Nyamagazi area, approximately 15 km north-west of Richmond and 30 km south-west of Pietermaritzburg, and has a catchment area of 984 km^2. In the early days it supplied sufficient water to prevent the mouth from becoming blocked with a sand bar, an occurrence which is so common along the Natal coast when the quantity of water flowing down the streams is insufficient to breach the sand deposited by wave and tidal action. It would appear that prior to the construction of the Shongweni dam in 1927 on this river the mouth was not known to have blocked, and even after this it was only occasionally blocked, generally during droughts.

The significance of a blocked river mouth lies in the depth and salinity of the water held and in the period of inundation, for the impounded water may cover vegetation established on the lower banks. If the mouth blocks frequently, (although waves may wash over the bar, at least soon after it is formed) the greater bulk of the water is fresh or relatively so, having originated in rain falling in the catchment area. The period of inundation may vary from days to months. The impounded water, of low salinity, has little or no flow rate. The result is that conditions are created that are completely different from a tidally influenced estuary where salinities vary from almost fresh water to full sea-water strength and, with evaporation, may, in parts, even exceed full sea-water strength (35‰ locally). Furthermore, inundation in a tidally influenced estuary is for brief periods only; the length of time varies with topography, as well as with those factors which influence the tides themselves. The presence of salt water, even for brief periods, causes flocculation and deposition of colloidal clay particles, so that the soils of such an area are also affected.

After 1952, the Sipingo River mouth became blocked so frequently that this created a health problem that was later rectified by the construction of a piped outlet for the mouth. This, although allowing some water to move in and out of the estuary, prevents the extremely low water levels that may occur when the mouth is open from being reached and, whilst the natural mouth is blocked, it restricts very much the amount of tidal water able to enter the estuaries, particularly during neap tides.

When the Sipingo River mouth is open, the amount of tidal water able to enter varies, not only with spring and neap tides, but also with the seasons and local weather conditions. The topographical gradient also is particularly important in this regard and its influence on the vegetation is discussed under the Halosere. According to the S.A. Naval Hydrographic Office Tide Tables (1963 and 1964), the mean range of Spring Tides in Durban is 1,708 m and for Neap Tides the mean range is 0,457 m. During the equinoctial periods this is greater for springs and less for neaps than at other times, and, as mentioned above, this may be further tempered by prevailing weather conditions. Thus, during the period March-December 1963, for example, a maximum range of 2,286 m and a minimum of 0,305 m for one full tidal fluctuation was recorded. In relating tidal levels to the Trigonometrical Mean Sea Level, figures for this same period show that the maximum tidal height in Durban was +1,346 m, minimum high tide reached +0,127 m, maximum low tide +0,076 m and minimum low tide —1,092 m.

Connected to the estuary of the combined Sipingo and Mlazi Rivers is a blind lagoon, also tidally affected at least when the Sipingo River mouth is open. Early residents (K.O. Elgie and O.E. Bjorseth in personal communication) recall that this lagoon was approx. 7,5 m deep in 1910 or thereabouts, but, through siltation, is very shallow nowadays. A considerable amount of soil is visible at extreme low water level, but is not seen when the mouth is blocked because the height of the landward end of the pipes, mentioned above, is such that it does not allow the same low level to be reached that might occur with an open mouth at extreme low spring tide. Siltation was undoubtedly accelerated by the opening of a canal in 1906 from the top of this lagoon into the Sipingo River for boating purposes. Although this canal was eventually closed in 1927, the waters of several floods passed through it and, as shown in Fig. 46, the Mlazi River at one time had deposited so much silt in the older Sipingo channel in the estuary that the Sipingo River, at least at low water, at times flowed directly through the boating canal and into the lagoon before joining with the Mlazi prior to entering the sea.

The Mbokodweni River mouth becomes blocked frequently and a lagoon, the long axis of which runs parallel to the shore, forms immediately behind the relatively narrow beach. Impounded water may back up to 1 km or even more from the beach, but the bar is often breached before this distance is reached, either naturally or aided by man.

Owing to the presence of a low ridge of calcareous sandstone forming a barrier along the beach from the north-eastern end of the Mbokodweni lagoon, the exit to the sea is towards the southern end, whereas the river enters the lagoon at its northern end. Even where the mouth is situated, the presence of a low rock shelf does not permit the entry of as much sea water, or the attainment of such low levels, as at the Sipingo estuary. It also facilitates blockage by wave-deposited sand. The vegetation, in keeping with the aquatic and edaphic factors, is quite different from that of the Sipingo lagoon and estuary. Erosion by the Mbokodweni River into the hills at either end of this lagoon has increased its length. Towards the end of 1968, however, the lower part of the southern bank was stabilized with rocks which, to date, have prevented further southward movement.

The local topography has been, and still is, influenced by the following factors in addition to man.

(i) Wind, in that it shifts unstabilized soil, particularly that deposited by the ocean on its shore, the sand of which when dry is blown further inland to form dunes which, when colonized, tend to be linear and parallel with the shore or, when denuded of vegetation, tend to be parallel with the main axis of the responsible wind.

(ii) Rivers, in that they cause undercutting and slumping of banks, infilling of deeper parts at some times and scouring of channels at other times; they introduce soils from various places outside the study area, and local drainage patterns have been altered through the changing of river courses or through the deposition of alluvial material on the banks of channels.

(iii) Vegetational cover, since this tempers the effect of erosion by wind and water.

(iv) The ocean, which provides the sand for wind-blown dunes, which through differential incutting causes bays to be formed, and through general incutting, causes the seaward face of the supralittoral rock shelf to be either vertical or overhanging.

Also, in places where the supralittoral shelf has been breached, the sea has undercut the major hills and caused slumping to give rise to very steep seaward slopes (Fig. 6). Changes in sea-level relative to land, are reflected in the wave-cut platforms or benches readily seen in the rocks at the seaward base of the main hills. Earlier higher sea-levels have no doubt influenced the deposition of alluvium in the formation of the Isipingo Flats.

A marine platform approx. 7 m above mean sea level is evident at the seaward base of

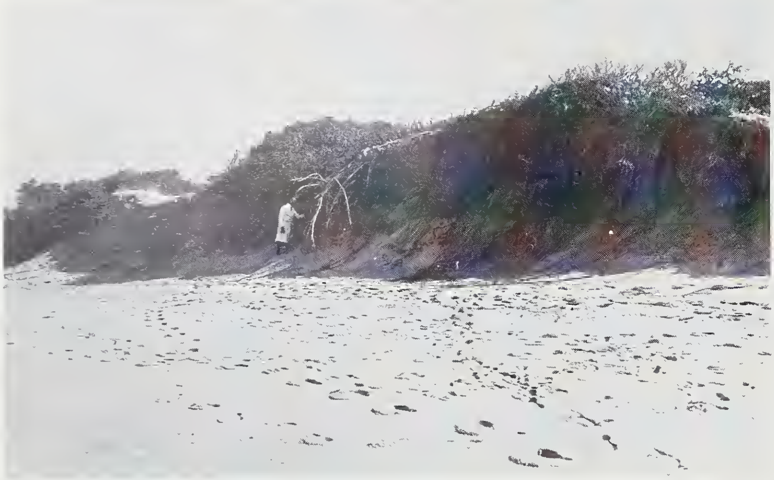


FIG. 7 - Scrub-colonized strand dunes at Isipingo North incut by high seas. Pioneer communities removed by earlier storm waves

Donsagolo, at Tiger Rocks (Fig. 15) and just south of the Mbokodweni River where Maud (1968) measured it at 8 m; according to him (loc. cit.) these relics represent a sea-level at 8 m above present level. Another sea-level at 4,5 m above the present level is better represented in this locality, since almost all of the remainder of the supralittoral rocks, other than those which have collapsed, have a horizontal upper surface at approximately this level (Fig. 6). Lower sea-levels represented by marine platforms at 0,0 m, 0,2-0,3 m, 0,4 m and 0,7-1,1 m are also described for this locality by Maud (loc. cit.) and all of these here mentioned are suggested by him as representing glacio-eustatic sea level movements rather than tectonic movement as suggested earlier (King & Maud, 1964).

An apparent increase in active incutting by the sea in several places at Isipingo Beach and Isipingo North, particularly noticeable over the past 20 years and resulting in the destruction of a considerable amount of strand and hillside vegetation, is possibly the result of the increase in sea-level that has been suggested in evidence communicated by L.C. King (1953). An example of incutting by storm waves into dunes is shown in Fig. 7.

1.4 GEOLOGY AND SOILS

The major hills, i.e. Donsagolo in the north, the main Isipingo Beach hill, the hill south of the Mbokodweni River and Jeffels' Hill in the west, consist of red sand overlying yellowish to white sand, while at the seaward bases of these hills an indurated calcareous sandstone occurs. McCarthy (1967) has shown that these sands represent a weathered counterpart of the Bluff Beds, for which a Pliocene age has been suggested by three independent palaeontologists (King, 1966; McCarthy, 1967). The calcareous sandstones are Bluff Beds truncated by wave action, representing different sea levels, and, in regard to the supralittoral rocks, are overlain by Quaternary raised beach deposits which are either sandy or conglomeratic consisting of sand, gravel, small boulders and shells.

The littoral and infralittoral rocks extend along the whole length of the study area except for the section immediately north of the Sipingo River mouth to Reunion Rocks. The supralittoral rocks are less extensive, but occur immediately south of the Mbokodweni River mouth, at Tiger Rocks, along the greater part of the base of the main Isipingo Beach hill to the Sipingo River mouth, with small often partly buried outcrops between these localities, and again at the base of Donsagolo.

Modern wind-blown dunes of white sand form the remainder of the higher ground of the study area. This white sand differs markedly from the weathered Bluff Beds in regard to its water-holding capacity, a feature of ecological importance. The white sand has little or no clay fraction, Maud (1968) however mentions a 1% clay content, whereas the red sands are often markedly clayey and may stand almost vertically where cut. McCarthy (personal communication, 1969) states that the clay content of these weathered beds may be as much as 27,2% (4%-27,2%): in addition, the iron oxide which gives the red coloration to these superficial layers possibly also aids in reducing the size of the air spaces in the soil. Where wind-blown, the weathered soils tend to be paler and to have a lower clay content.

The lower-lying parts and the Isipingo Flats in general consist of alluvial and deltaic deposits of fine to coarse sand, silt and clay. All river systems, particularly the Mbokodweni and Mlazi, are responsible for the siltation of the lower-lying parts. In regard to deposition of river-borne material, particle size sorting results in a more sandy material being deposited along the banks or in the bed of the main transporting stream, while the finer particles are carried further afield. Material deposited in the form of levees often alters the local drainage pattern. This, together with a possible change in soil type, influences not only existing vegetation, but also the whole pattern of subsequent succession.

The Mbokodweni and, formerly, the Mlazi Rivers tend to deposit a considerable amount of sand along their banks and flood plains, whilst the Sipingo River, at least for that part in the study area, has muddy banks. An explanation for this might lie partly in the fact that the Sipingo River traverses relatively less sand-producing geological formations in its course than the other two and, probably more importantly, in the fact that the major rivers are freshwater and have a more steady and apparently greater flow rate than the Sipingo River which, in the study area at least when the mouth is fully opened, is directly influenced by tidal saline water and has a low flow rate for its width. In fact, as others (as quoted by King, 1953) have pointed out, "the lower course of the Isipingo River is typical of land submergence". For the greater part of the study area this river is, "therefore", really an elongated drowned estuary. As mentioned above, the flow rate will affect the size of particles deposited: in addition, flocculation of colloidal clay particles through the mixing of turbid river water with salt water causes this clay material to settle as a soupy ooze, generally organically rich, which on drying tends to form a sticky, and later a hard, black mud. Where alluvial deposits, containing some clay with sand, are left by flood action above tidal influence, this material becomes relatively sandier above with age, because with rain-action the finer particles are washed down leaving a more porous sandy material above. Thus visible deposits above tidal influence tend to be mainly of sand, not only through initial particle size sorting, but also through subsequent action by rain water. Burrowing by crabs (as mentioned in Section 5.2.2.1) aids local turnover and sorting. This influences the type of vegetation able to colonize such a deposit and, should there be no colonization or only very slow invasion, such transported surface sands on drying may be subject to wind-blow.

In regard to present soils in the study area, it is pointed out that there has been a considerable amount of soil brought in by man, especially since 1965 when the low-lying part in the vicinity of the Sipingo Lagoon, and between this lagoon and the main access road to Isipingo Beach, was infilled. This infilled material is a red clayey sand or sandy clay, containing also gravel, pebbles and a few boulders, brought in from the hills westward of the study area and is quite foreign in this state to the environment in which it has been placed. The infill of the Isipingo Flats was obtained from Jeffels' Hill and comprises the upper red and paler lower weathered Bluff Beds. A similar material was obtained from the cut in the Bluff ridge north of Donsagolo, as infill for the present Louis Botha Airport, but this (in 1949) affected directly only a small part of the northern section of the study area.

At the end of 1969 material dredged from the Sipingo River and Lagoon was pumped on to the earlier 1965 infill, mentioned above; thus raising the level further.

See Figs 3 & 4 (inside back cover) for the locality of the features mentioned above.

CHAPTER **2**

Climate

The majority of the data given here have been extracted from unpublished records made at the Meteorological Office at Louis Botha Airport, which station is situated approximately 1,5 km from the northern corner of the study area.

2.1 INSOLATION

Due to cloudiness in summer, the mean number of hours of sunlight per day is less than 50% of the theoretical possible, whereas from May to August it is above 60% with the maximum number of hours in July which, however, represents 72% of the maximum possible compared to 73% in June (Table 1 and Fig. 8). The number of days of full or nearly full sunshine and of completely overcast days gives a further indication of the lack of cloud in winter (Table 1).

TABLE 1 - Sunshine at Louis Botha Airport. For period (i) March 1956 to February 1969; (ii) 1958-1964 (data from unpublished record, Weather Bureau, Dept of Transport)

	(i) Daily hours			(ii) Mean number of days	
	Maximum possible	Mean	Mean as % of possible	Completely overcast	Sun 90-100%
Jan.	13,8	6,1	44	3,0	1,0
Feb.	13,2	6,6	50	2,7	2,0
Mar.	12,3	6,7	55	0,9	2,3
Apr.	11,4	6,9	60	1,9	4,4
May	10,7	7,2	67	1,0	6,3
June	10,2	7,4	73	0,7	8,7
July	10,4	7,5	72	1,0	6,6
Aug.	11,0	7,3	67	1,3	4,7
Sept.	11,9	6,4	53	3,6	2,4
Oct.	12,8	5,5	43	4,7	1,1
Nov.	13,7	5,4	39	3,4	0,6
Dec.	13,9	6,5	47	3,1	1,7
Year	12,1	6,6	55	27,3	41,9

In regard to the intensity of insolation, Table 2 gives the percentage of maximum surface insolation for latitude 30 °S on a level surface and on a south-facing and a north-facing slope of 33°. The natural repose angle of dry sand is between 30° and 35° (Holmes, 1965), thus the two sides of a wind-blown dune, a common topographical feature in the study area, should they face north and south, have markedly different microclimates.

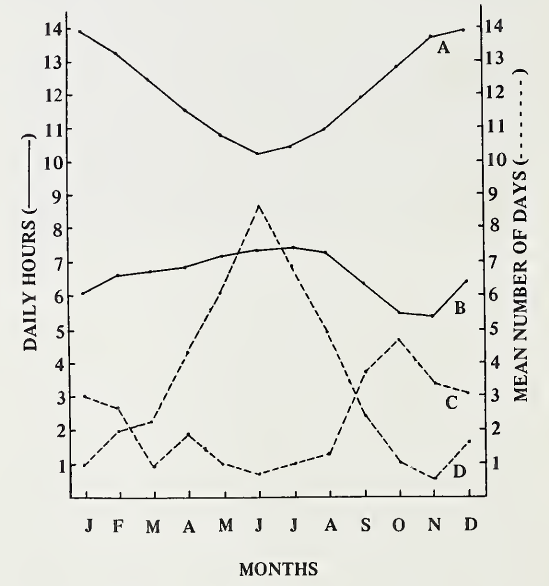


FIG. 8 - Sunshine at Louis Botha Airport
A. Max. number of hours per day } March 1956
B. Mean number of hours per day } to Feb. 1969
C. Mean number of days completely overcast } 1958 to 1964
D. Mean number of days with 90%-100% sun }

TABLE 2 - Percentage insolation and length of shadow of vertical stake (10 units tall) at midday on level surface and on north- and south-facing slopes of 33°, at latitude 30 °S

Time of year	Shadow length in units			% maximum surface insolation		
	South-facing slope	Level surface	North-facing slope	South-facing slope	Level surface	North-facing slope
Mid-winter	129,7	13,5	8,6	6,19	59,55	93,70
Equinox	11,0	5,8	5,0	45,40	86,60	99,86
Mid-summer	1,5	1,2	1,3	77,11	99,35	89,53

TABLE 3 - Light intensities under different types of vegetation in the Isipingo Beach area

Species	Light intensity as % full sunlight
A: Mangroves	
Avicennia marina, large tree	14,10
Avicennia marina, c. 3,7 m tall, shadiest part	3,38
Mixed tall *Avicennia marina* and *Bruguiera gymnorrhiza*: 0,6 m from margin	0,74
Mixed tall *Avicennia marina* and *Bruguiera gymnorrhiza:* 1,0 m from margin	0,50
Bruguiera gymnorrhiza, large, marginal	0,84
Bruguiera gymnorrhiza, large, within stand	1,54-3,54
Bruguiera gymnorrhiza, young, within stand	1,21-1,79
Bruguiera gymnorrhiza, young (0,6-2,4 m tall) marginal to stand, 0,6 m from outer margin	0,51
Bruguiera gymnorrhiza, young (0,6-2,4 m tall) marginal to stand, 1,2 m from outer margin	0,33
B: Dune communities	
Scaevola thunbergii, well developed	7,81-12,5
Passerina rigida, up to 1 m tall	4,41-28,82
Chrysanthemoides monilifera subsp. *rotundata*	4,69-18,75
Eugenia capensis, clump 1 m tall	1,21-2,08
Brachylaena discolor	4,21
Mimusops caffra, 3 m tall	1,19-2,25
Early dune forest, canopy 4,5-5,5 m tall	
(i) above *Isoglossa woodii* (0,75 m tall)	1,88-3,44
(ii) below *I. woodii* (0,75 m tall)	0,31-0,78

An idea of the degree of penetration of the sun's rays into vegetation on slopes of different aspect, as well as the altitude of the noon sun at mid-summer, mid-winter and the equinox, may be obtained also from Table 2. From this it will be seen that, for the greater part of the year, a north-facing slope has a higher % insolation than a level surface which, however, receives more direct sunlight at midday in midsummer than the north-facing slope.

The seaward slope of the main Isipingo Beach hill varies in steepness but the south-facing slope of the amphitheatre below the highest point has a mean angle of 45°. This means that in winter this particular slope does not receive any direct sunlight at all and, on a more gentle slope of 33°, a 10 m tall tree would have a minimum shadow length of 129,7 m long in mid-winter. Such a low insolation on these southern slopes, or on the south side of vegetation on other slopes, or on the level, modifies the microclimate very considerably, particularly in regard to evaporation of condensed or precipitated moisture.

Light intensity on surface layers of the soil is markedly affected by vegetation as has been shown by Bews (1912) and Killick (1959). Whilst local records did not give as low a figure as that recorded by Bews (1912) of 0,17% of full sunlight in "Yellowwood Bush", nevertheless very low intensities (i.e. less than 0,5%) were recorded (Table 3) under the mangrove, *Bruguiera gymnorrhiza*, especially under a pure stand of young plants 0,6-2,4 m tall, and also under the gregarious suffrutex, *Isoglossa woodii* which was only 75 cm tall at the time, in early dune forest.

2.2 TEMPERATURE

A mean annual temperature of 20,2 °C and an annual variation from this mean of approx. 4 °C, suggests a mild to warm temperature without excessive variation of the mean. However, records of extreme temperatures show that 40,8 °C has been recorded during October (1958) which is

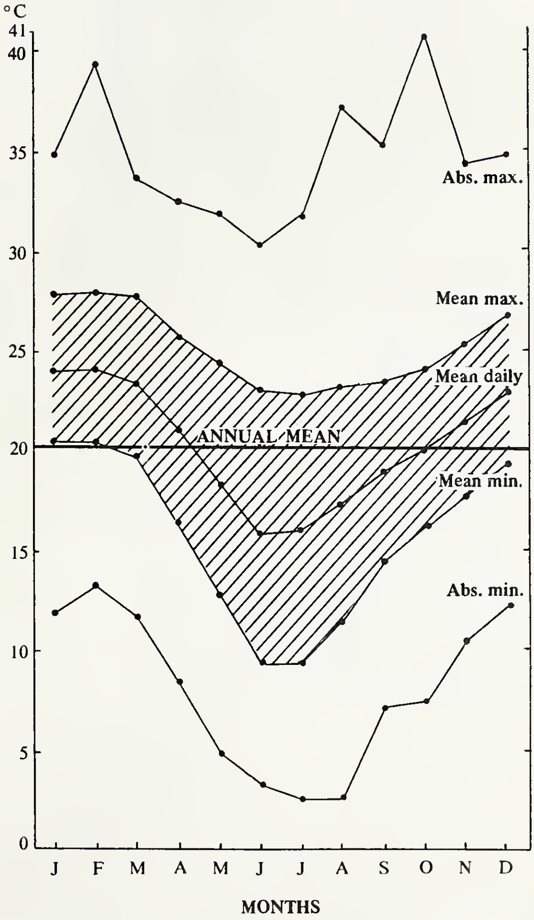


FIG. 9 - Temperature chart for Louis Botha Airport for 13-year period, March 1956 to February 1969

TABLE 4 - Screen temperature at Louis Botha Airport (°C), 13-year period March 1956 - February 1969 (data from unpublished records, Weather Bureau, Dept of Transport)

	Absolute maximum	Mean daily maximum	Mean	Mean daily minimum	Absolute minimum
Jan.	34,7	27,7	23,9	20,4	11,9
Feb.	39,4	27,9	24,0	20,4	13,3
Mar.	33,6	27,7	23,4	19,6	11,6
Apr.	32,5	25,7	21,0	16,4	8,6
May	31,8	24,4	18,4	12,7	4,9
June	30,2	22,9	15,8	9,3	3,3
July	31,7	22,7	16,0	9,4	2,6
Aug.	37,1	23,2	17,2	11,4	2,6
Sept.	35,2	23,4	18,9	14,4	7,3
Oct.	40,8	24,0	19,9	16,2	7,5
Nov.	34,3	25,3	21,4	17,9	10,6
Dec.	34,7	26,7	22,9	19,3	12,3
Year	40,8	25,1	20,2	15,6	2,6

almost 21 °C above the mean for that month and minima of 2,6 °C have occurred in both July and August. The warmest month is February, while the coolest is June (Fig. 9 and Table 4).

It is pointed out that the Weather Station at Louis Botha Airport is situated at an altitude of 7,6 m on the north-western side of the Isipingo Flats approximately 2,8 km from the sea, from which it is separated by the flats and a high ridge (the southern extension of the Durban Bluff, terminating in Donsagolo Hill), thus it is possible that summer maxima may be somewhat higher at this station than in much of the study area which abuts directly onto the shore of the Indian Ocean.

Frosts occur occasionally in the lower-lying parts of the central and western section of the Isipingo Flats and, although light and of infrequent occurrence, it would appear that they are more frequent than the records made at the Louis Botha Weather Station would indicate. Apart from the station's exposed position and altitude not favouring the recording of frost, records of this phenomenon are based on observations officially made at 08h00 and, since these frosts are generally very light, signs of their occurrence have generally disappeared by this time. However, for the period July 1956 to June 1965 two official records of light frost were made at the Louis Botha Airport, both in the month of June: this includes one made at 07h00, earlier than the official recording time. In addition to these records, four subzero minimum grass temperatures were recorded during June and one in July at Louis Botha Airport during the period March 1962 to July 1965. While these low grass temperatures varied from -0,2 °C to -1,3 °C, only one (-0,4 °C) corresponded with an officially recorded frost and another (-0,2 °C) occurred on the same morning that a light frost was observed in a low-lying place in Cato Manor, Durban.

An examination of the topography of the Isipingo Flats and its environs shows that the seaward hills and ridges form an impediment to cold air drainage. However, cold air is still able to escape to the sea through restricted parts, such as along the rivers and drainage canals. It is probable that it is because of this impediment that frosts are able to develop in spite of the proximity of this locality to the sea which, in this part, is affected by the warm Moçambique current.

The only adverse effect of such frosts as occur locally, noted in respect to the vegetation, is that frost damages, or even kills, sugar cane especially if this is young. Such damage, incidentally, has been encountered periodically from the early days of the sugar industry on the Isipingo Flats; for example, in July 1860, it was reported that "... acres of young cane have been blighted and destroyed by the frost" (The Natal Mercury).

2.3 WIND

As may be seen from Tables 5 and 6 the prevailing winds are north-easterly and south-westerly which, over the year, occur with almost equal frequency, namely 8,86% and 8,73% respectively. The major sectors, however, are north-north-east to east-north-east and south to south-west with the latter sector (24,1%) slightly more frequent than the former (21,8%) over the year, although winds from the north-north-east to east-north-east sector are the more frequent during the latter part of summer (January-March).

June is the calmest month although, throughout the period May-July, there is a high frequency of calms and light winds. October has the lowest frequency value for calms and the highest average velocity, but September has the greatest frequency of the stronger breezes of 5,5 m/s and above (see Table 7). Table 8 shows the maximum velocities over one hour and individual gusts; from this it may be seen that the strongest winds blow from the south or south-south-west.

In addition to their general ecological and climatic effects, winds are important in regard to the local vegetation and topography in that they influence tidal extremes (although this may be an oversimplification of a problem involving atmospheric pressure), or, by affecting the surface and currents of the sea, they may influence sand deposition or removal by wave action. Wind removes sand from places where the vegetational cover has been disturbed or before vegetation has been able to colonize the particular part. This leads

TABLE 5 - Percentage frequency of calms and winds of different directions for Louis Botha Airport. Based on hourly values for the 9-year period July 1956 to June 1965 (data from unpublished records, Weather Bureau, Dept of Transport)

	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	CALM
Jan.	3,17	10,75	11,53	5,03	3,85	1,85	1,96	3,11	6,82	8,99	8,08	2,93	0,76	0,21	0,10	0,52	30,33
Feb.	4,17	9,71	9,74	5,82	4,41	1,36	1,80	2,69	8,17	8,66	6,51	2,59	0,69	0,05	0,11	0,39	33,10
Mar.	4,81	11,47	9,86	5,12	2,76	1,28	1,63	2,42	7,27	8,39	6,99	2,27	0,60	0,15	0,19	1,08	33,71
Apr.	3,18	7,89	8,24	4,43	1,81	1,02	1,13	1,56	7,07	7,56	8,24	2,85	1,13	0,35	0,23	0,71	42,61
May	2,43	5,51	4,72	3,09	2,06	0,91	1,27	1,42	4,85	5,87	7,83	3,30	0,99	0,22	0,49	0,93	54,11
June	2,33	3,98	5,00	2,39	1,71	1,22	1,31	1,36	4,68	5,22	6,88	3,94	1,14	0,57	0,62	1,37	56,28
July	3,11	5,53	6,63	3,15	1,81	1,14	0,91	1,54	3,75	6,23	7,26	4,63	1,40	0,33	0,42	1,82	50,36
Aug.	3,21	7,68	8,89	4,99	2,30	1,45	1,24	1,90	4,61	8,95	10,01	3,72	1,60	0,31	0,37	0,97	37,81
Sept.	3,70	8,94	9,98	5,59	2,15	1,25	1,13	2,30	6,28	11,03	13,01	4,09	1,20	0,23	0,35	0,65	28,12
Oct.	4,09	9,56	11,07	5,12	3,14	1,60	1,72	2,30	7,54	12,01	10,96	4,20	1,37	0,18	0,24	0,34	24,57
Nov.	2,44	9,46	10,43	5,26	3,72	1,48	1,70	2,72	10,86	10,26	9,37	2,78	0,68	0,08	0,28	0,35	28,13
Dec.	2,66	9,35	10,20	5,41	3,35	1,57	1,76	3,03	9,62	10,07	9,50	2,73	0,60	0,13	0,10	0,31	29,61
Year	3,27	8,32	8,86	4,61	2,75	1,34	1,46	2,19	6,78	8,60	8,73	3,34	1,02	0,24	0,29	0,79	37,41

FIG. 10 - Showing effects following removal of dune pioneers and scrub through biotic and marine disturbance at Isipingo North: forest being buried, buildings destroyed and topographical profile changed by wind-blown sand. Dark shrub to right of nearest derelict building, *Carissa macrocarpa*, with crown hedged by on-shore winds, level with top of wall. Wind-trained thicket (relict of Closed Dune Scrub) in centre middle distance. Relict *Mimusops caffra* Woodland near distant buildings. Other features shown: southern extremity of Reunion Rocks, left foreground; Dune Forest on white sands, centre and right background; Isipingo Beach hill, left background; more southerly trend of coastline beyond study area, left far distance

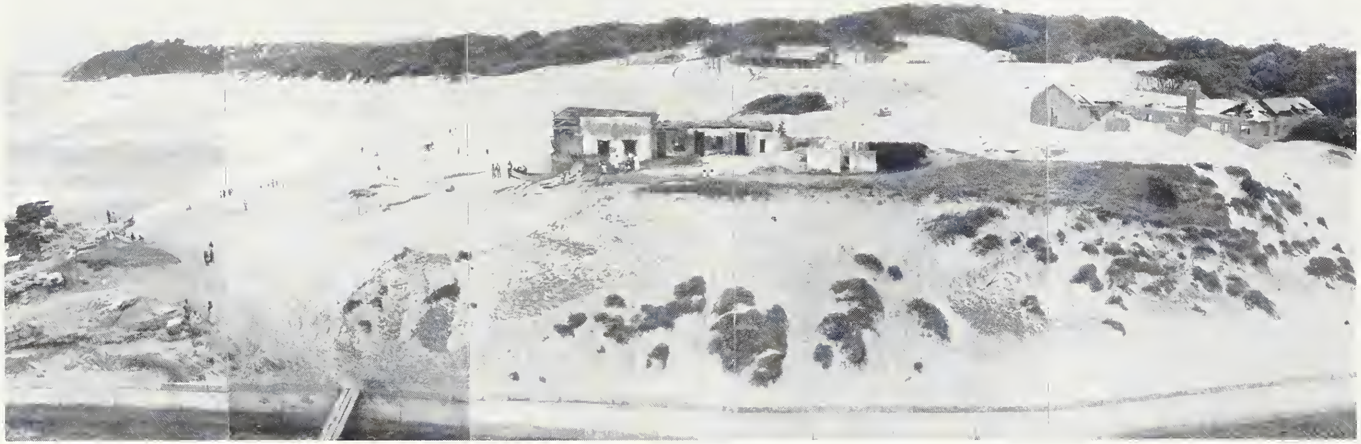


TABLE 6 - (i) The sector from where the wind blows most often and the % frequency of that wind and (ii) the % frequency of on-shore winds in the Isipingo Beach area. Based on hourly values for winds and calms recorded at Louis Botha Airport for the 9-year period, July 1956 to June 1965 (data from unpublished records, Weather Bureau, Dept of Transport)

	(i) Most frequent winds		(ii) % frequency of on-shore winds: north-easterlies	
Month	Sector	% frequency	Excluded	Included
Jan.	NNE + NE + ENE	27,3	39,7	51,2
Feb.	NNE + NE + ENE	25,3	39,4	49,2
Mar.	NNE + NE + ENE	26,5	35,7	45,7
Apr.	S + SSW + SW	22,9	32,8	41,1
May	S + SSW + SW	18,6	27,3	32,0
June	S + SSW + SW	16,8	24,8	29,8
July	SSW + SW + WSW	18,1	25,8	32,4
Aug.	SSW + SW + WSW	22,7	35,5	44,3
Sept.	S + SSW + SW	30,3	42,7	52,7
Oct.	S + SSW + SW	30,5	44,4	55,5
Nov.	S + SSW + SW	30,5	45,4	55,8
Dec.	S + SSW + SW	29,2	44,3	54,5
Year	S + SSW + SW	24,1	36,5	45,3

TABLE 7 - % frequency of different wind forces for Louis Botha Airport, based on hourly values for the 9-year period July 1956 to June 1965 (data from unpublished records, Weather Bureau, Dept of Transport)

	Velocity								
Beaufort scale	0-1	1	2	3	4	5	6	7	8 & over
m.p.h.	0-2	3	4-7	8-12	13-18	19-24	25-31	32-38	39 & over
m/sec.	0-1,2	1,3-1,5	1,6-3,3	3,4-5,4	5,5-7,9	8,0-10,7	10,8-13,8	13,9-17,1	17,2 & over
Jan.	30,33	4,88	17,64	18,49	17,65	8,54	2,21	0,25	0,00
Feb.	33,10	4,86	15,85	20,05	17,62	6,81	1,56	0,15	0,02
Mar.	33,71	4,72	16,20	17,40	17,14	8,51	1,97	0,31	0,03
Apr.	42,61	4,26	15,20	16,14	13,64	6,37	1,54	0,19	0,05
May	54,11	4,64	14,76	13,26	8,98	3,20	0,82	0,22	0,01
June	56,28	4,83	14,18	12,50	8,07	3,33	0,79	0,02	0,00
July	50,36	5,11	14,07	14,17	10,83	4,26	1,02	0,20	0,00
Aug.	37,81	4,42	14,41	15,93	14,98	8,78	3,27	0,31	0,07
Sept.	28,12	3,81	13,33	18,29	19,58	11,45	4,49	0,77	0,15
Oct.	24,57	4,24	15,80	20,76	18,92	10,63	4,76	0,31	0,00
Nov.	28,13	4,75	15,54	19,32	19,17	9,44	3,47	0,17	0,00
Dec.	29,61	4,21	16,14	19,94	18,15	9,90	1,93	0,12	0,00
Year	37,41	4,56	15,26	17,17	15,38	7,61	2,32	0,25	0,03

TABLE 8 - Wind speed at Louis Botha Airport, for the 13-year period March 1956 to February 1969 (data from unpublished records, Weather Bureau, Dept of Transport)

	Maximum velocity over 1 hour		Maximum gust		Average velocity (1962-1968 only)
	m/s	Direction	m/s	Direction	m/s
Jan.	16,5	SSW	29,1	SSW	3,80
Feb.	17,9	S	32,2	SSW	3,84
Mar.	21,9	SE	30,8	SSW	3,76
Apr.	19,2	SSW	30,0	SSW, SE	3,04
May	17,4	SW	25,9	SSW	2,37
June	15,6	SSW	25,9	SSW	2,15
July	15,6	S, SSW, ENE	24,1	ENE	2,59
Aug.	22,4	S	32,6	S	3,53
Sept.	19,2	S	32,2	S	3,98
Oct.	17,9	SSW	27,3	SSW	4,25
Nov.	18,8	S	30,4	SSW	4,07
Dec.	16,1	SSW	32,6	SSW	3,98
Year	22,4	S	32,6	S, SSW	3,44

to burial or excavation of inanimate objects as well as plants which may be killed unless, like sand dune pioneers, they are able to survive such treatment. Examples of wind erosion were recorded in many places including the Reunion Rocks area of Isipingo North which is shown in Figs 10 and 11.

Burial by sand is accompanied by an increase in the effect of the abrasive action of wind-blown sand on younger parts of plants, thus causing defoliation or death of non-tolerant plants or parts thereof, as is shown in Figs 12 and 13.

Another observed effect of winds in strand ecology was that they transported portions of dried plants or animals after they had been washed up by the sea. This wind-blown debris, although sparse,

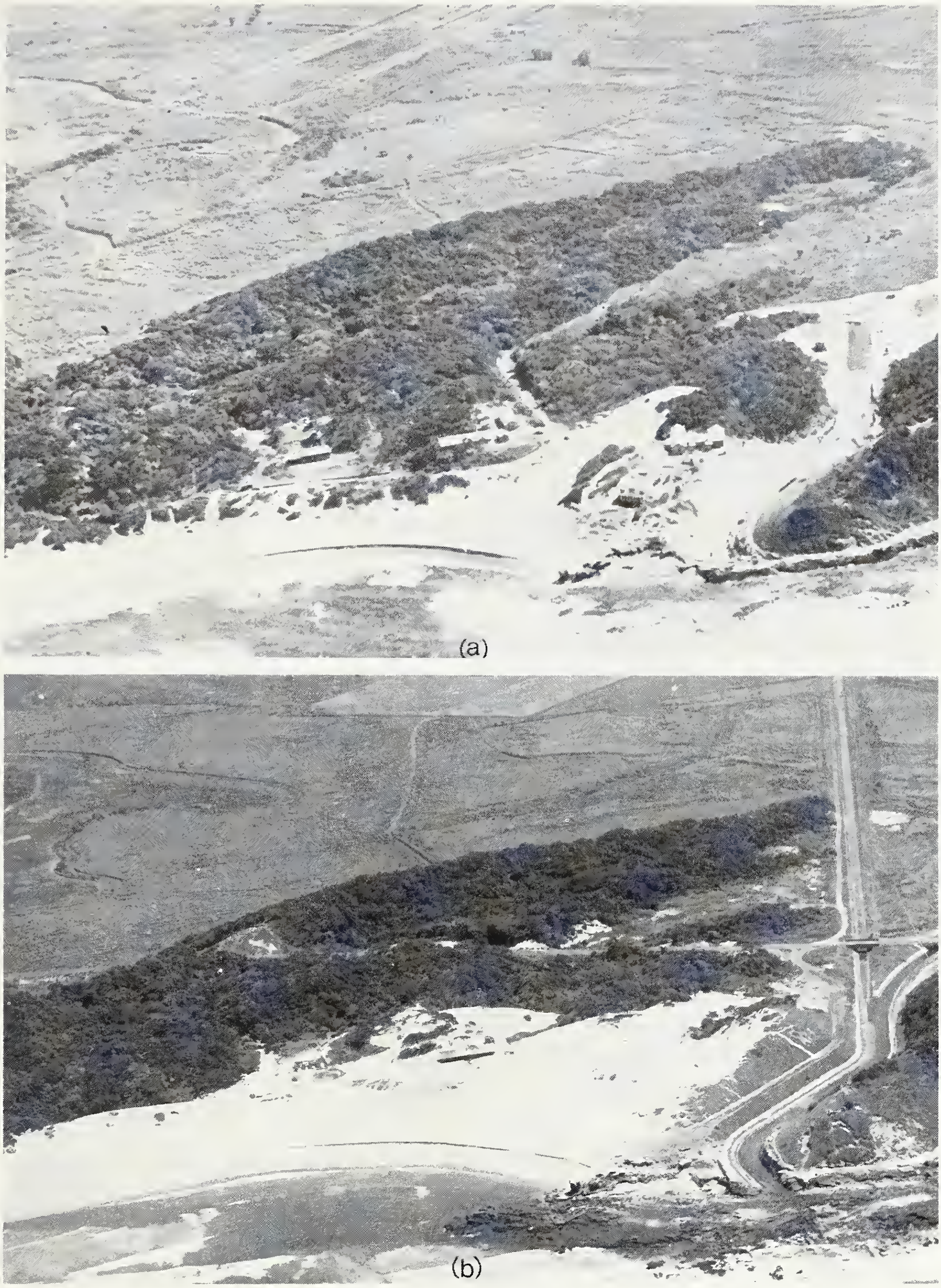


FIG. 11 - Wind-blown sand encroaching into forest following removal of sand dune pioneers and scrub. (a) Sept. 1946 (copy of photo by Lynn Acutt): (b) Jan. 1965. In (b) the removal of buildings to the right of the group effected by man in 1961-62

accumulated in early dune vegetation and helped to increase the very low organic content of the substrate. Likewise these winds aided the distribution of fruits of some of the dune pioneers, including those of *Scaevola thunbergii* which are mainly water-distributed.

In addition to the above effects an important effect of on-shore winds is that they carry salt-spray which kills unprotected renewal buds, as has been pointed out by Bayer (1938). This leads to stunting, deformation or hedging of the exposed vegetation, examples of which were recorded along the full

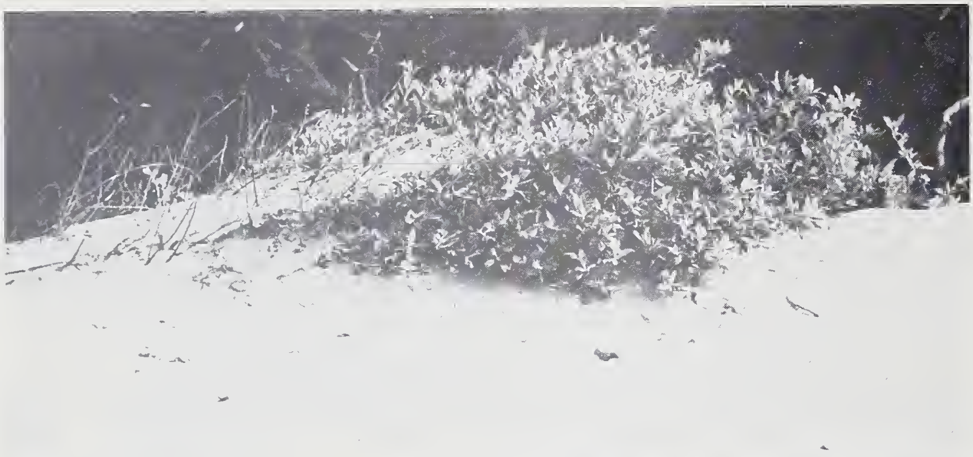


FIG. 12 - *Brachylaena discolor* buried and abraded by wind-blown sand after destruction of vegetation to windward

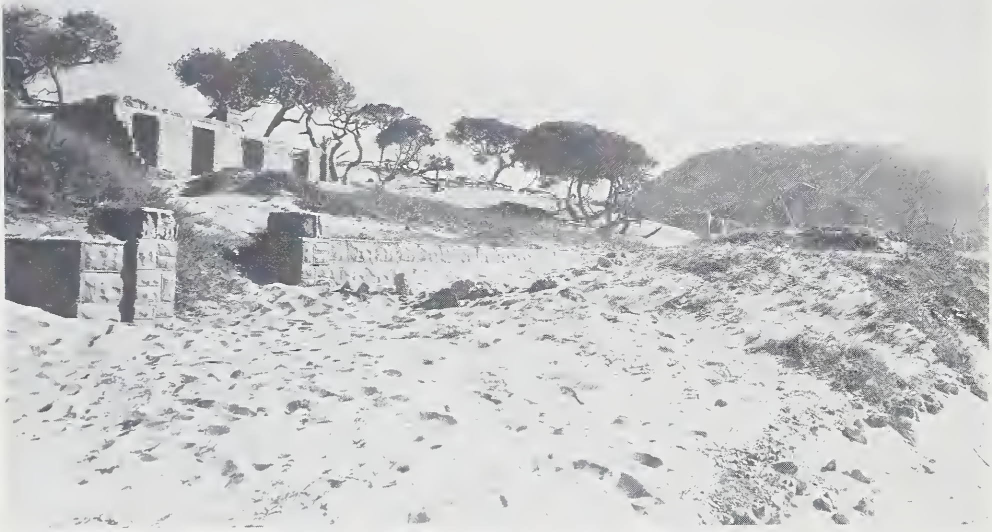


FIG. 13 - Effects of wind-blown sand following removal of protective vegetation.
Sand accumulation on former road and garden; wall partly buried; concrete blocks abraded; buildings undermined and collapsed in parts; vegetation in background destroyed by wind-blown sand and increased salt-spray.
Sporobolus virginicus and *Gazania rigens* var. *uniflora* colonizing sand in foreground; *Cyperus natalensis* and *Stenotaphrum secundatum* in middle distance. In background, relic *Mimusops caffra* and one tall *Eugenia capensis* (central)

length of the seaward side of the study area. In particular, extremely stunted vegetation occurred on or just above the supralittoral rocks where the salt-spray is most plentiful (see Figs 6 and 11).

The stronger winds have a more marked effect, especially in regard to sand transportation and in their effect on the ocean, but light winds are also very important, particularly where transportation of salt-spray is concerned.

Salt-spray is introduced into the atmosphere from breaking waves, but the cause of this varies. Crests of waves, raised by light winds, begin to break when the wind force reaches 3,6 m/s thus, even without waves breaking on the shore, salt-spray is introduced into the air stream and, if the wind direction is suitable, carried onto the land. Through waves breaking on the shore, salt-spray is introduced into the atmosphere independently of the presence of wind (albeit much reduced if there is no wind). This is increased on a rocky shore-line, such as is much of the seashore in the study area, and even further enhanced by the shape and structure of the rocks in places (see Fig. 14). Thus, even the light on-shore breezes are important as carriers of salt-spray, and it has been noted that, at times when there seems to be no measureable wind velocity, salt-spray drifts on to the shore from the wave zone in the form of a fine haze, no doubt aided in its drift by local convection currents created by differences in temperature between the sea and the land.

The on-shore winds in the Isipingo Beach

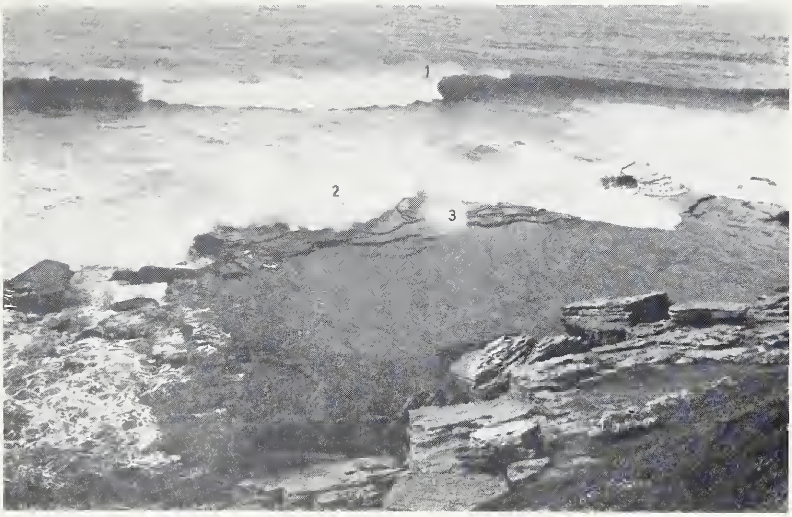


FIG. 14 - Three methods by which salt-spray is introduced into the atmosphere:
1. from off-shore breakers;
2. from waves breaking against rocks;
3. from the forcible expulsion of sea-water and air through narrow exit of cave (blowhole)

area, where the coastline has a mean northward direction of just east of north-east (47°), are those that blow from the east-north-east to the south-west and include the strongest winds recorded for this locality. Such a prominence as Tiger Rocks, jutting out slightly from the mainland, would be affected also by the north-easterly winds at high tide, especially if this was a spring tide. Table 6 gives the frequency of these winds based on hourly values, including calms, for each month and for the year. If the north-easterlies are included, recordable winds blow off the ocean on to some part of the shore in the study area for more than 50% of the total time of each month from September to January. Thus the importance of these winds may be readily appreciated.

2.4 PRECIPITATION

2.4.1 Rainfall

Table 9 gives the rainfall record for Louis Botha Airport for the thirteen-year period, March 1956 to February 1969. While records covering all aspects of rainfall measurement over a longer period are not available, parameters for total annual amount since 1895 were obtained through the kindness of the late Mr G. Ogle. This is possible since the site of the present Louis Botha weather station is close to that of the former Reunion Sugar Estate offices where rainfall records were kept. These longer records show that the annual mean is 1 027,2 mm, only 6,5 mm more than records calculated for the past thirteen years, but the extremes are more excessive. The lowest annual amount over the whole period of recording was 604,5 mm (1900), which followed the next lowest parameter of 609,6 mm (1899), whereas to date the Louis Botha minimum is 723,0 mm (1966). Maxima are 1 737,9 mm (1917) for the whole period and only 1 305,5 mm (1958) for the last thirteen years.

The annual distribution of rainfall is such that 67,6% of the annual total falls during the summer months of October to March which compares favourably with the 33-year record for Durban Point of 67% (Climate of S. Africa: II, 1954). June, July and August are particularly dry, but only on

TABLE 9 - Rainfall record for Louis Botha Airport for the 13-year period March 1956 to February 1969 (data from unpublished records, Weather Bureau, Dept of Transport)

	(i) Amount (mm)				(ii) Number of days on which rain fell		
	Mean	Maximum	Minimum	Maximum in 24 hours	Mean	Highest	Lowest
Jan.	143,3	254,1	37,5	109,1	16	22	9
Feb.	108,7	272,6	50,2	85,0	13	17	10
Mar.	122,7	245,1	21,4	106,1	14	19	7
Apr.	107,1	302,0	18,9	142,5	11	16	7
May	50,4	152,2	3,0	79,0	7	12	3
June	33,3	139,1	0,0	108,7	5	8	0
July	37,7	147,1	1,4	100,3	6	12	2
Aug.	42,1	100,8	2,5	70,8	6	9	4
Sept.	60,3	118,9	23,2	60,6	10	18	5
Oct.	88,7	250,6	34,5	86,7	15	18	9
Nov.	106,7	205,3	42,9	52,9	17	24	12
Dec.	119,6	330,5	59,9	162,5	16	21	11
Year	1 020,7	1 305,5	723,0		135	163	120

one occasion to date has the Louis Botha Airport received no rain at all in a month (June 1959).

In addition to the general effect of rainfall on local vegetation, other aspects relative to the study area are mentioned briefly.

Droughts have not only a direct effect on individual plants, particularly noticeable in regard to mesic herbs and deciduous trees, but also on the environment as a whole. Deciduous trees may lose their leaves either partly or completely as a result of a severe summer drought and should the drought be broken these same trees may respond by producing flowers or at least a new set of leaves, thus two leaf flushes and/or two flowering periods may occur within the one year (see *Celtis africana, Croton sylvaticus, Albizia adianthifolia* i.a. in Chapter 6). In regard to effect on the general environment, droughts increase the fire hazard, but this is not particularly important in this area nowadays. Droughts can also affect the salt/fresh water ratio in tidal estuaries. If a river mouth remains open during drought the water in the estuary will tend to be more saline than under conditions of normal river flow and this will affect the vegetation, favouring the halophytes. More generally, however, droughts result in the lack of sufficient water in rivers needed to overcome the deposition of a sand bar by wave action at the mouth; thus the mouth becomes blocked and, as long as inflow of water overcomes evaporation even though it may not be sufficient to breach the bar at the mouth, a lagoon will be formed. Such an accumulation of water which is generally fresh or only very slightly brackish also has a marked effect on vegetation and in the case of the Sipingo system has proved in the past to be deleterious to some of the mangrove populations especially to *Bruguiera gymnorrhiza*. As mentioned in Chapter 1, such lagoon formation is not able to take place in the Sipingo estuary now that a pipe has been introduced to ensure drainage.

Excess rainfall causes washaways while standing water in poorly drained places also influences the type of vegetation occupying such situations. Soil erosion by direct rainfall may be seen in the reddish soils of the major hills, but this is seldom severe unless aided by man, while in the white sands of the modern dunes this is of no consequence at all since these sands are extremely porous and there appears to be no run-off from these parts.

High rainfalls cause flooding and, bearing in mind the size of the catchment area of the local rivers (Fig. 1), it is not only the rainfalls of this immediate locality which are important in this respect, but also those falling over a much wider area. Flooding of the rivers in various degrees is not uncommon and has had the effect of undercutting banks, scouring channels, depositing alluvial material and directly destroying existing vegetation. Most of the floods are minor, limited to a slight spreading across the relevant flood plains and to possible river bank damage, but several have been of such magnitude that the whole of the Isipingo Flats have been inundated and alluvium has been deposited over a considerable area; furthermore, structural damage to buildings and bridges has often occurred. Such floods have occurred since the earliest days and, for the study area itself, records go back to 1845 when the Mlazi overflowed its banks and the flats (The Natal Mercury, 1954). A more destructive flood was that of 1856 when, in April following heavy rains (Durban 685,8 mm in one week and Lower Umkomaas 838,2 mm), the whole of the Isipingo Flats were inundated; all three rivers were in full flood, crops and buildings were destroyed and the Mbokodweni River, in particular, deposited vast quantities of sand (The Natal Mercury, 1856 and 1861). Such records continue right up to the present period, although the last severe flood which caused inundation of the full length of the flats was in 1935. Since the diversion and canalization of the Mlazi River in 1952 the potential flood danger has been reduced and this will be reduced even further once a flood-diversion canal which is in the process of being constructed from the Sipingo River into the Mbokodweni River, is completed.

2.4.2 Thunderstorms

Thunderstorms do not generally develop over this area, but they may spread over it from their places of origin further inland. The mean number of days on which thunder has been heard at the Louis Botha Airport is shown in Table 10.

TABLE 10 - Mean number of days on which (i) Thunder was heard and (ii) Fog or mist and (iii) Dew was recorded at Louis Botha Airport for periods mentioned below (data from unpublished records, Weather Office, Dept of Transport): (i) July 1956 to June 1965; (ii) July 1956 to June 1965; (iii) July 1957 to June 1965

	(i) Thunder heard	(ii) Fog (including shallow ground fog or mist)	(iii) Dew
Jan.	4,7	0,4	3,0
Feb.	3,0	0,1	4,9
Mar.	5,6	0,1	7,0
Apr.	3,2	0,6	11,0
May	1,4	2,2	16,1
June	0,9	2,1	18,5
July	1,3	2,3	16,5
Aug.	0,4	1,8	13,0
Sept.	2,1	1,9	8,0
Oct.	4,0	1,1	3,8
Nov.	6,7	0,6	2,7
Dec.	5,6	0,3	3,0
Year	38,9	13,6	107,5

Lightning has on only one occasion been recorded as being responsible for causing a fire in this region. This was a fire in a sugar cane field in December 1930 (The South African Sugar Journal, 1930, XIV: 805). Generally rain accompanies these storms and probably extinguishes most fires that may start from such a strike before they are able to develop.

2.4.3 Fog and mist

Shallow ground fog or mist is of frequent occurrence on cool, calm, clear nights in low-lying places on the Isipingo Flats, especially east and south-east of the Louis Botha Airport in the former Mlazi valley, where not only is the area of low altitude but also certain protection from light wind is afforded by the seaward ridge and dunes. Much of the fog which may spread to cover the Louis Botha Airport is dissipated after sunrise and therefore may escape record. Nevertheless Table 10 is included to show the mean number of days on which fog and mist were recorded, although it must be considered that this represents an absolute minimum. If the whole Flats were to be considered these figures would undoubtedly be higher.

2.4.4 Dew

The remarks concerning the occurrence and recording of fog and mist might well apply to this phenomenon as well. Dew is of common occurrence throughout the study area, and is often very heavy, especially in winter on clear, calm nights. Dew may be another direct source of water for plants especially for members of the lower orders and shallow-rooted vascular plants, since water runs off the surface on which it condenses, including leaves, and drips onto the soil. This has been observed in the open dune communities on white porous sand where such a source of water is probably very important when rain is not available, such as in winter. An idea of the quantity of water which may drip from leaves or twigs may be gathered from an observation where, at 14h30 on a warm day in winter, a patch of sand in open dune scrub was still damp from earlier dew-drip.

Dew readily evaporates when subjected to direct insolation, therefore topography, natural or artificial, is very important in this regard. As discussed briefly under Insolation (Section 2.1), the seaward slopes of the main Isipingo Beach hill and Donsagolo are of sufficient steepness and aspect to have no or very little direct sunlight on them during winter and it has been noted that during this season dew may not evaporate at all during the day in places on these slopes.

2.4.5 Hail

Hail is of only extremely rare occurrence in the study area. When it occurred, the stones were very small and sparse and no local damage was reported. The only record made by the author for the study area was a light fall accompanying heavy rain in November 1950. During the 9-year period, mid-1956 to mid-1965, no records of hail at Louis Botha Airport were made, although in this same period there were three recordings for the city of Durban.

2.5 RELATIVE HUMIDITY

The relative humidity is high throughout the year although the mean is at its lowest in the dry winter months (Table 11).

TABLE 11 - Relative humidity based on hourly values at Louis Botha Airport for the 13-year period March 1956 to February 1969 (data from unpublished records, Weather Bureau, Dept of Transport)

	Mean %	Highest %	Lowest %
Jan.	81	100	30
Feb.	81	100	30
Mar.	80	100	30
Apr.	79	100	22
May	77	100	17
June	73	100	14
July	75	100	14
Aug.	75	100	12
Sept.	78	100	12
Oct.	79	100	11
Nov.	81	100	34
Dec.	80	100	33
Year	78	100	11

The lowest relative humidities are generally associated with a weak coastal low pressure system, generally overhead, giving rise to a "Berg" wind or, rather, a Berg wind effect in which dry inland air moves into the coastal low and heats up as it descends. Most of these low relative humidities are followed by a southerly wind which generally arrives very suddenly and sometimes with considerable force giving rise to what is locally referred to as a South-westerly Buster.

The lowest relative humidity was recorded at 10h40 on 4 October 1958, when the temperature was 40,8 °C giving a Saturation Deficit of 51,37 mm. This occurred with a north-westerly wind of 37 km/h, immediately before there was a sudden switch to a south-westerly wind gusting to 84 km/h at 10h55. Air pressure at the time was low, being 100,7 kPa. This series of events is typical of a Berg wind condition followed by a South-westerly Buster.

CHAPTER 3

Historical background

Because finer details assume greater importance when dealing with the ecology of a small area compared with that of a large area, somewhat more than the main outline is given here, but it is considered that all are of ecological significance.

According to Bryant (1929) members of the Tuli clan of the later Nguni Bantu arrived on the shores of this section of the Natal coast by 1800 and, although not numerous, spread themselves along the coastal strip from just north of the Mgeni River (in what is now Durban) southward to the Mkomazi River, i.e. approximately 30 km north and south of the study area. Here they remained with their cattle until they were routed by the Zulu invasions, the first of which was in 1821 (Bryant, 1929).

These were not the first inhabitants of the study area, however, since several middens, which have been unearthed within 1 km of the shoreline in this area, contain pottery with characteristic decorations indicating that Blacks who "arrived on the shores of Natal towards the end of the seventeeth century" (Schoute-Vanneck, 1963) had lived here before them.

When, in 1824, the first white settlers arrived in the Durban area, the only inhabitants were a few stragglers from the Zulu invasions. These few, without crops or cattle, had hidden themselves in the dense bush in the vicinity of the Bluff.

After 1824, Blacks drifted back to the vicinity of Durban and, offering themselves as subjects to the white men, sought protection from further Zulu invasions.

In regard to the inhabitants of the study area itself, by 1835, H. Ogle had five kraals near the mouth of the Mlazi River (Bird, I, 1888), and, in about 1825, the Hlongwa clan moved up the coast to settle along the Mbokodweni River as subjects to H. Fynn (Bryant, 1929). The latter, however, left when Fynn, and other whites, left the Durban area fearing an attack by the Zulus under Dingane in 1833. While the whites returned to the Durban area, the Hlongwas did not.

In 1829 another group, the Mande faction of the Cele tribe, sheltered "with the emaTulini at esiPingo" and remained hidden in the "darkest recesses of the isiPingo jungle" (Bryant, 1929) until after the scare of the Zulu invasions of 1833. They, however, had left by 1840.

Over the years, other Blacks settled in the area westward of Isipingo or south of the Mbokodweni River which was declared Native Location (Umlazi Native Location No. 4676) and, in the study area south of the Mbokodweni River, Blacks continued to live until the early 1920's.

In regard to white occupation of the study area, Richard King, who had originally trekked to Durban in 1828 from the Cape Province, had, by 1839, "acquired some farmland at Isipingo and had built himself a house there" (Slayter, c. 1961), but neither he nor others were permanent occupiers until later in the 1840's. In a grant of land dated 1 Feb. 1849, the farm Isipingo No. 870 was given to Richard King (Surveyor General's records). This comprised 2 354 ha and included the greater part of the Isipingo Flats and hills, both on the seaward and immediate landward sides thereof, up to the Mbokodweni River. Thus, with the exception of that small portion south of the Mbokodweni River, this included all of the study area.

Soon after acquiring this land, King sold portions to various people who planted the land to crops of which the most important soon became sugar-cane, and, in 1852, "Isipingo became the true cradle of the S.A. sugar industry" (Osborn, 1964).

Development from this date onwards concerned mainly the Isipingo Flats. However, a house of one of the early farmers, Joyner, was built near the Mbokodweni Lagoon (on the Isipingo Beach side), but this disappeared later in the nineteenth century and in 1902 the only habitation on the Isipingo Beach hill was a rather tumble-down cottage near Tiger Rocks (Slayter, c. 1961).

Although there was no residential development on the Isipingo Beach hill, the vegetation in this vicinity no doubt suffered through firewood gathering since, by 1857, there were nine sugar mills in the vicinity of Isipingo and this had increased to fifteen by 1867. The steam mills required fuel and in The Natal Mercury of April 2, 1863, there was already a complaint concerning the lack of wood for burning.

In 1880 the railway from Durban reached Isipingo and this enhanced local prosperity, but mainly concerned that part lying outside the study area although it would have enabled more people to visit the beach and lagoon which was already a popular picnicking place.

A few people used also to visit Reunion Rocks, in the north-eastern corner of the study area, for picnicking or for fishing and, in 1899-1900, a house was built on the southern extremity of Donsagolo, while another followed in 1908 at the edge of the forest-clad white dunes (D. Tucker, personal communication). By 1915, it was noticed that sand was shifting through wind action where the dune vegetation had been disturbed (D. Tucker), but it was not until after the Second World War that this became a serious problem (see Figs 10 and 11).

1905 saw the beginning of township development at Isipingo Beach and in 1906 the land was sold by public auction and developed as a seaside resort. Destruction and disturbance of vegetation followed residential development. Another aspect of human interference may be seen in the construction of a stone wall along the base of the main Isipingo Beach hill, completed in 1910. Prior to this, the combined Sipingo and Mlazi Rivers, aided by sea action, were actively undercutting the north-eastern slopes of this hill which, through slumping, were very sparsely covered, particularly in two major slip faces. With stabilization of the base, these slopes have become recolonized and today these slopes are more or less fully clad with trees or large shrubs as the dominant growth form.

Also in 1906 a canal from the Sipingo lagoon was cut through into the Sipingo river forming an island of the intermediate former peninsula. The effect of this canal in aiding siltation has been dealt with in Chapter I. This canal was eventually closed in 1927.

In 1912 the Township of Isipingo North, on the northern side of the Mlazi River, was surveyed for Beach plots, but no residential development took place until the later 1930's apart from the two houses mentioned above which were excluded from the boundary of this township and one other house (later destroyed) near Isipingo Beach.

In 1916 a nine-hole golf course, the preparation of which had necessitated the destruction of a considerable amount of vegetation (including forest) on the white dunes and adjacent low-lying parts, was opened in Isipingo North.

In 1925 the Isipingo Beach Town Board was established and this ran the affairs of this residential township until 1962.

In 1926 Athlone Park, by then uninhabited, was separated from Native Location and set aside for a future White residential area. This, however, was not surveyed for houses until the mid- to late-1930's and, apart from a small military camp built during World War II, there was no residential development until after the War.

A distant construction, but one which had an effect on water flowing down the Mlazi River, was the building of the Shongweni Dam in 1927.

Towards the end of the 1920's another golf course was built. This became the 18-hole course on the Isipingo Flats on the right bank of the Mlazi River before it entered its estuary.

In 1931 the Durban boundary was extended to the current course of the Mlazi River, and Isipingo North was incorporated into the Borough of Durban.

After 1931, market gardens were developed extensively in drained swamps and low-lying grassland marginal to forest situated between Reunion Rocks and the Mlazi River. These, however, were later abandoned and the vegetation returned to reedswamp and grassland.

During the mid-1930's, a tea room was opened at Reunion Rocks. This enhanced the popularity of that place and, in turn, led to an aggravation of the problem of wind erosion of the local beach dunes and the destruction of the vegetational cover. By this time, the original houses, mentioned above, had disappeared and it was not until immediately before World War II that other houses were built in this area.

In 1936 the road called Kingsway was started; this became the main upper South Coast road and a part of it more or less forms the south-western boundary of the study area.

Following the outbreak of hostilities in 1939, the Union Defence Force took over part of Isipingo North and constructed a camp at Reunion Rocks adjacent to the houses and tea room already built. The U.D.F. constructed another camp approximately midway between the above one and Isipingo Beach, in former dune forest. Further destruction of dune vegetation and an increase in wind-blown sand followed the occupation of these sites, an effect which was even further aggravated by visitors after the war. The U.D.F. also levelled off part of the former golf course on the Isipingo Flats for use as an aerodrome and constructed a camp in this vicinity. A flood protection canal and dyke, built by the U.D.F., channelled flood water of the Mlazi into part of the Sipingo River and in the 1940's caused considerable deposition of sandy alluvium which resulted in the formation of sand-banks and, later, an island which became fixed by mangroves.

In 1945 another golf course was opened; this time in the Mbokodweni Valley where it is still in use.

The construction of the Louis Botha Airport was started in 1946. Although this lies mainly outside the study area, the various ramifications arising from its development had very serious repercussions on sections of the study area. Initially, in 1946-1947 a sand dyke was thrown across an ancient course of the Mlazi River which prevented water from the north-eastern section of the Isipingo Flats from entering the current Mlazi: such water was diverted into a concrete-lined canal which opens into the sea at Reunion Rocks. Such a shortening of the path taken by water to the sea accelerated drainage of this area, much of which was swampy, and, at the same time, reduced the amount of water flowing out of the mouth of the combined Mlazi and Sipingo Rivers.

In 1952 the Mlazi River was diverted into a concrete-lined canal which lies completely outside the study area. This diversion resulted in further reduction in the amount of fresh water flowing into the combined Sipingo and Mlazi estuaries with the result that the mouth became blocked by wave-deposited sand for such extensive periods that it created a health hazard. An attempt to overcome this was initially undertaken through mechanical clearing of the bar, followed in 1955 by the installation of a metal pipe which, in turn, was replaced by a permanent pair of concrete pipes in 1961.

Mining operations for minerals in the sand were begun in 1956 on the landward side of the southern extremity of the spur of high land extending southwards from Tiger Rocks (see Fig. 3), that is, adjacent to the northern end of the Mbokodweni River (Slayter, c. 1961). Such operations caused local destruction of vegetation and disturbance to the soil.

In 1961 the low-lying parts, mostly just north of the study area, were infilled with material from the landward side of Donsagolo Hill for the Shell-BP refinery. Within the study area the first effect of this industry was the construction of a road which necessitated the cutting of dunes, infilling of low-lying places and the destruction of a strip of dune forest.

Also in 1961, sand removal operations from the beach at the mouth of the Sipingo River were commenced. This has been continued, with a few halts, up until the time of writing and with apparent increase in activity in recent years. From 1961 until mid-1966 just over 191 000 m^3 had been removed (Francois, of Isipingo Sand; personal communication 1966). The immediate effect of such operations has been the destruction of dune vegetation both directly by the vehicles associated with the operation and by wind-blown sand moving into and burying existing vegetation, following disturbance of the dune scrub.

In 1962 an amalgamation of Isipingo Beach, Isipingo Rail (under which the Isipingo Flats fell) and Amanzimtoti took place, thus today all of the study area, south of the 1931 course of the Mlazi River, is incorporated in the Borough of Amanzimtoti: the part north of this river lies, as already mentioned, within the boundary of the City of Durban.

In 1963 (4 October) Isipingo Beach and Isipingo Rail (outside the study area) were zoned for Indian occupation. This had two major ecological effects within the study area: many former inhabitants moved only as far as Athlone Park which caused a considerable amount of clearing to be undertaken for residences mostly, however, just outside the study area boundary; and secondly, many of the Indian newcomers to the area did not favour the number of trees surrounding their houses, which resulted in clearing of vegetation in the old residential area as well.

During the 1960's, industrial development saw the end of the Agricultural era on the Isipingo Flats. Although sugar cane is still grown, the area occupied by this is reduced annually as industry spreads.

In 1963, soil was removed from the eastern spur of Jeffels' Hill to be used as an infill for a steel works erected outside the study area. Again in 1966 and continued until the time of writing, a vast quantity of soil was removed (changing completely the topography of Jeffels' Hill) and used to fill in the Isipingo Flats from The Avenue (the main access road to Isipingo Beach) southwards, to a height of approximately 3 m above mean sea level, preparatory to developing this as an industrial area. In the course of this development the vegetation along the Sipingo River in this section was completely destroyed and the river course straightened and narrowed. Other water courses and drains, likewise, have recently become concrete-lined canals with complete destruction by burial of all former vegetation.

Another recent development involving local disturbance and destruction of existing vegetation was the construction of a pipe-line from the oil refineries, situated to the north of the study area, to Kynoch's factory at Umbogintwini (end-1966 to early 1967). This relatively narrow swathe has now been recolonized by secondary plants.

Subsequent to the construction of the Shell-BP refinery, starting in 1961, Isipingo North has suffered further interference. Initially this was the development of two borrow pits from which white sand was taken for use outside the study area; in one place (near Reunion Rocks) this necessitated the destruction of dune forest. Finally, in 1969, the forest clad dunes of Isipingo North have been, and still are in the process of being, completely destroyed with the exception of a narrow strip on the seaward side; the vegetation has been bulldozed and burnt, the dunes levelled and the adjacent flats infilled to accomodate expansions to the oil refinery and for an oil tank depot which will be fed from an off-shore intake.

In recent years there has been considerable development of a residential area in the hills of the catchment area of the Sipingo and Mbokodweni Rivers. In the case of the former, at least, such an increase in population has led to organic pollution of the Sipingo River, or so it would appear from the odour and appearance of the substrate in the uppermost part of the study area at times and, early in 1969, a population explosion of a very vigorous form of *Pistia stratiotes* occurred in the Sipingo River in the vicinity of and just above the National Road bridge.

To summarize, the study area as a whole passed through the phase of being sparsely populated by Blacks, and very sparsely so with no crops or cattle for a few years (early 1820's), into one where, for part of the area, cattle were kept. This continudd until recently, having given way in the early 1850's to sugar-planting on the Isipingo Flats where in the last few years Industry has taken over from Agriculture. For the rest of the area, it was not until the twentieth century that residential development took place and this was mainly in the Township of Isipingo Beach with, however, a minor development at Reunion Rocks and later, especially following deproclamation of Isipingo Beach as a white area in 1963, in Athlone Park, south of the Mbokodweni River. Fig. 3 illustrates some of the more recent changes.

Vegetation

4.1 LITHOSERE

The only exposed rock occurring naturally in the study area is the indurated calcareous sandstone occurring along the shore-line, as discussed in Chapter 1.

Slumping of the main hills in response to undercutting by sea- or river-action shows that this calcareous sandstone extends vertically and horizontally landwards. However, the indurated parts are discontinuous or softer than where they are directly exposed to the sea or to wave-splash.

Induration is achieved through cementation of sand, gravel and other inclusions by calcium carbonate. Under acid conditions (such as rain-water charged with carbon dioxide) the carbonate is slowly converted to soluble calcium bicarbonate which is then able to be leached from its original site. As the calcium bicarbonate solution loses water by evaporation or if carbon dioxide is removed, calcium carbonate is precipitated (Holmes, 1965); thus re-cementation of sand particles, and other inclusions, may take place. Likewise, calcium carbonate is precipitated from sea-water as it is being evaporated or when carbon-dioxide is lost following its being heated, as by the sun in intertidal pools at low water. Krige (1932) pointed out that, at the edges of intertidal rock pools, wind-blown sand may be cemented by this precipitated calcium carbonate to form a calcareous sandstone.

In those situations which are subjected to salt-spray-bearing winds or to sea-water itself at some times, and to rain-water at other times, the cementation-decementation relationships at any one time tend to be complex. Plants contribute to this complexity and are likewise influenced by it, particularly in the early phases of succession.

The products of chemical and physical weathering of this calcareous rock form a sand extremely similar to modern dune materials with which there is considerable admixture. Therefore, where sands occur in any depth, excluding crevices in the exposed rocks, or where sand has blown from where it was recently deposited by the sea, the plant ecology will be discussed as part of the **Psammosere (Section 4.2).**

The discussion here is limited to the plant ecology of the supralittoral rocks, i.e. the indurated sandstone above extreme tidal limit.

The main, hardened, section of this supralittoral rock has little width. This is shown by the partial isolation from the mainland by some of the relicts (as at Tiger Rocks, Fig. 15) and is revealed further by the removal of the covering soil

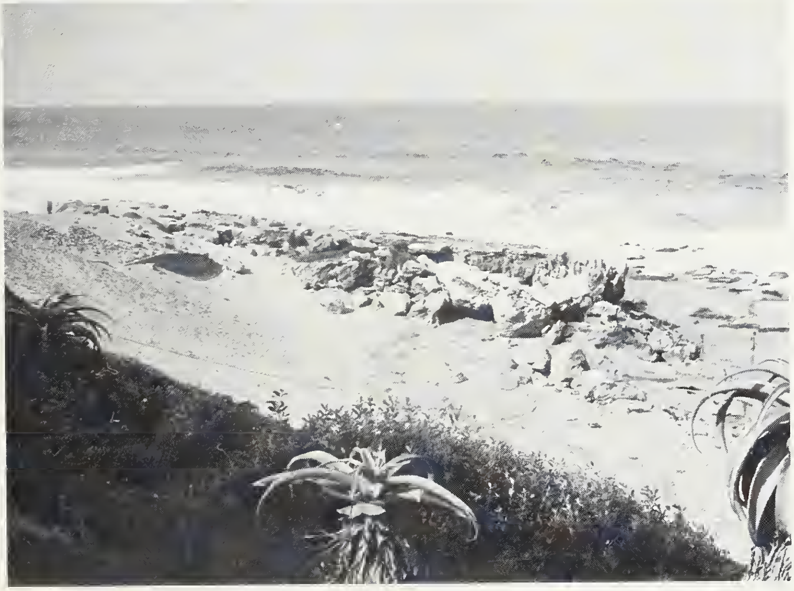


FIG. 15 - Tiger Rocks, Isipingo Beach, from west. Marine-eroded supralittoral rocks separated above from mainland by wind erosion aggravated by trampling

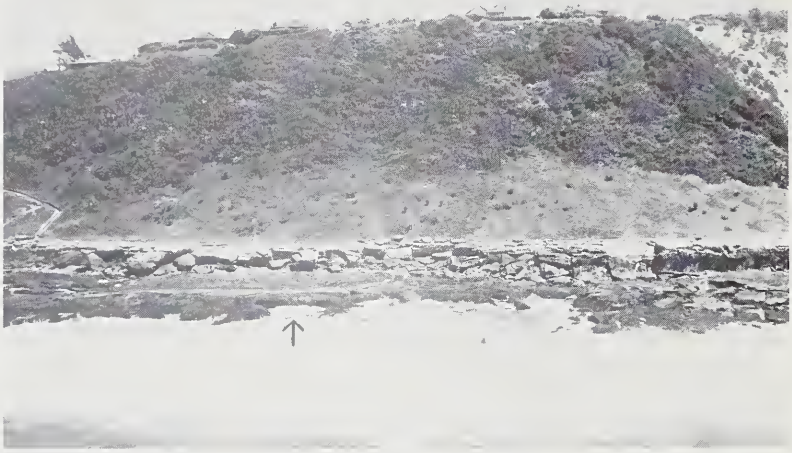


FIG. 16 - Low aerial view of part of seaward slope of Isipingo Beach hill, at low tide. Arrow points to cavernous shelf with landward exit, forming blowhole (see also Fig. 14). Other features shown progressively further away: collapsed supralittoral rocks; dwarf salt-spray vegetation with *Aloe thraskii* emergent; later dominance of *Strelitzia nicolai* (large leaves) and *Brachylaena discolor* (light foliage), finally *Mimusops caffra* (dark). Upper part of unstable slope with prominent *Passerina rigida* in extreme right background

and vegetation where slumping of the main hills has occurred. This isolation of some sections, together with the fact that there is considerable vertical fracturing of the rocks throughout (resulting from undercutting), reduces the amount of seepage water able to reach the exposed rocks. This is particularly the case where fractures are parallel to the coastline as are the majority here; other fracture lines, at right angles (or nearly so) to these, are also numerous. Thus, for the greater part, the plant communities of these rocks are reliant on rain falling directly on the rocks for their freshwater supplies.

Through undercutting and fracturing, crevices of various widths occur throughout the series and the exposed faces are overhanging, vertical or tilted (through collapse), see Fig. 16.

The upper surface of the exposed rock, although planed, has many hollows of various sizes in which water from rain or wave-splash is able to collect, as it may also do in the narrower fissures, at least temporarily.

Altitude and aspect, including width and depth of crevice, determine the amount of exposure to sun, wind and wave-splash; thus also to salt-spray, desiccation and abrasion by wind-blown sand.

The products of weathering of the rock are readily removed by gravity, water or the strong and frequent winds (see Section 2.3). Sand and organic debris collect only where some protection from the prevailing winds is afforded. Such sites often have a reduced amount of salt-spray, but they may be subjected to wave-splash if low enough or if the lower rock formations encourage additional splash. Where drainage is adequate, rain leaches salts from the soil. Although rain moves uncolonized soil it may, in depressions, act as a temporary stabilizer, even on the upper windswept parts.

Added to the adverse environmental factors is the effect of trampling by man. These rocks have a large number of visitors and the vegetation on the flat, exposed parts suffers considerably from trampling. Trampling is particularly severe where the sand of the high hills meets the rock platforms and, in such situations, the effect of trampling accentuates the distinction between these two

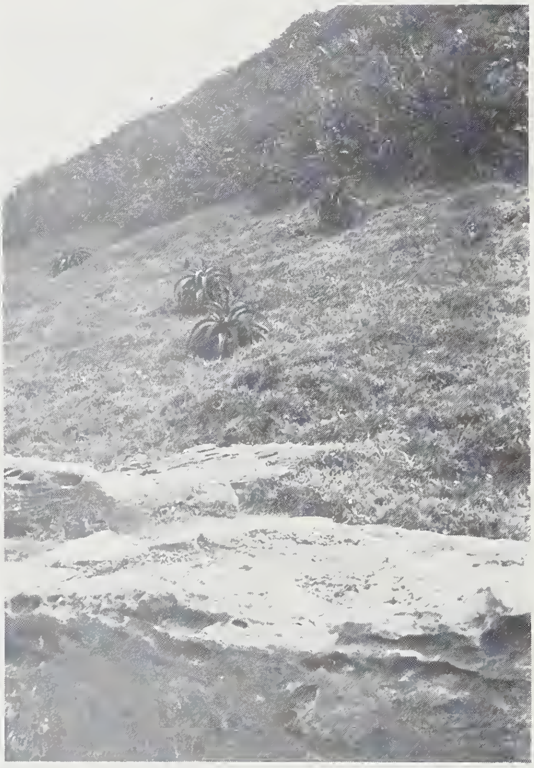


FIG. 17 - Low, compacted growth forms of *Gazania rigens* var. *uniflora* and *Sporobolus virginicus* where trampled on upper platform of supralittoral rocks. *Sporobolus virginicus* taller where protected by rocks on left

Dwarfed vegetation, with exception of *Aloe thraskii*, with canopy few centimetres to approximately 70 cm tall on steep slope above rocks

Strelitzia nicolai initially dominant further up slope

(Photo taken immediately to right of, and looking towards, Fig. 16) habitats. Disruption of the cover follows trampling and the soil is then removed by wind or water. Where crevices or unevenness of the upper surface of the rock protect the main stems or bases of the plants, these plants react to trampling by having a very compacted growth form (see Fig. 17).

4.1.1 Non-vascular plant communities

4.1.1.1 ALGAE

The role of algae, in particular that of the ubiquitous Cynanophyta, in aiding weathering or consolidation of calcareous rock requires more investigation. The majority, if not all, appear to aid chemical dissolution of the cementing material in the presence of adequate freshwater. However, as desiccation occurs, loose particles, particularly those held by filamentous forms, may be cemented by re-precipitated calcium carbonate. In addition, it is suggested that superficial or endolithic Cyanophyta, during photosynthesis when water supplies are critical, probably also aid in precipitation of calcium carbonate.

Algae occurring in heavily wave-splashed places are excluded from this discussion even though, from an altitudinal point of view, they are above the highest tide level.

In shaded situations or where direct insolation is much reduced and where fresh or brackish water is available, even if only as a temporary seep, filamentous Cladophoraceae (*Cladophora* sp. and *Chaetomorpha* sp.) and *Gelidium* spp. are found. These occur in woolly mats and are the largest of the local algae occurring above extreme tidal level. Although they occur low enough to be subjected to wave-splash (at least at high spring tides), they often receive little or none of this directly, since they occur in crevices or small concavities where they are sheltered.

While the two groups occur together, the Cladophoraceae are more widely distributed and occur also in slightly drier or less saline situations than *Gelidium* spp. These both appear to aid in chemical weathering of the calcareous rock since they occur in small concavities or crevices and their substrate, under conditions of prolonged dampness from freshwater, is superficially soft. In the upper parts of wider crevices or situations out of the direct path of strong on-shore winds, seedlings of *Sonchus oleraceus* frequently germinate on filamentous mats of *Cladophora* sp.

Cyanophyta are very well represented, at least numerically so. Non-filamentous forms may be regarded as the main pioneers of these rocks occurring as they do on calcareous material in a variety of habitats. They occur where protected from or exposed to sun, wind and wave-splash, on vertical mesoclinal or xeroclinal faces and on overhanging or horizontal lower or upper surfaces. They may be superficial on rocks, shells, polychaete tubes; in or on re-precipitated calcium carbonate, or in a clearly distinguishable layer, 1-2 (-3) mm broad, up to 6 mm beneath the surface of indurated rock.

The endolithic Cyanophyta, occurring in bands within the rock, are frequently associated with local exfoliation from the surface of the rock since the flaking occurs at the algal layer. In the majority of cases this would appear to have been due to a combination of chemical and physical weathering, through dissolution of calcium carbonate on the one hand and differential expansion and contraction on the other.

Filamentous Cyanophyta occur where water (fresh or saline) is available, even if only temporarily but for longer periods than where many of the non-filamentous forms are found. They therefore occur on damp surfaces, exposed to the sun or permanently shaded, or in hollows on the upper surface of the rocks where, not only water, but also wind-blown sand and organic debris are able to collect.

They generally form superficial mats which, whilst living, hold de-cemented particles or additional material which may be blown, dropped or washed onto the mat. When dry, however, these mats break up and the loosened material may be blown away, particularly if this is on vertical faces, where leaching is facilitated. On the other hand, as mentioned earlier, if sufficient calcium carbonate is present re-cementation of the substrate and additional material may take place, thereby building up the rock.

Of more immediate importance in the vascular plant succession of these supralittoral rocks are those filamentous Cyanophyta which cover soil collected in depressions on the upper surface of the rocks. Although these also break up when dry, they protect the soil from wind-blow for a longer period than is the case with uncolonized sand. Furthermore, when these algae die, they contribute to the organic content of the soil. Thus invasion by vascular plants is facilitated.

4.1.1.2 LICHENS

The lichen populations on these supralittoral rocks are poorly represented, in numbers of both individuals and species. Where they do occur, the crustose and foliose forms generally cause superficial disintegration of the rock. This material together with remains of the lichens helps to form a soil, but frequently this is lost from the site of origin which is usually in dry situations or on vertical faces.

Crustose lichens are widespread, but nowhere abundant, although they are locally common on the inland-facing vertical to overhanging rock surfaces of Tiger Rocks. Although generally in places where they are protected from excessive salt-spray or from the abrasive action of wind-blown sands, some will occur in places subjected to moderate salt-spray and in the direct path of winds.

Foliose lichens are rather rare (although one is locally common at Tiger Rocks), occurring out of the direct path of strong winds and salt-spray.

It would appear that only one species of fruticose lichen (*Ward* 5010) occurs on these supralittoral rocks and this has been recorded from only two localities. This is locally frequent on the pitted wall of a crevice in collapsed sandstone, lightly shaded and protected from the main salt-spray-bearing winds; on only rare occasions have other specimens been recorded from a more exposed situation, but well out of wave-splash, and also on a pitted surface.

4.1.2 Vascular plant communities

In this locality, vascular plants will colonize wherever soil, freshwater and adequate sunlight are available. The pioneers vary with variation in micro-environment in which topographic and edaphic factors are of paramount importance.

In heavy salt-spray and even where occasionally wave-splashed, but out of the direct path of the very strong winds, in shallow soil and in full sunlight, *Arthrocnemum natalense* var. *natalense* occurs as a rare pioneer. This may give way to *Chenolea diffusa* which, however, is not tolerant of as much salt as the former. *C. diffusa* is a common pioneer in deeper soils (often finer sands with organic material). It sprawls across the rocks and extends into heavy salt-spray, but is not tolerant of strong winds and generally occurs where it is not splashed directly by waves, other than at exceptionally high tides.

The remainder of the vascular plants, whilst mostly tolerant of salt-spray as such, are above the wave-splash zone, although some of the quicker-growing plants spread into this zone during the rainy season.

The first vascular plant to colonize wind-blown sands with a low organic content is *Gazania rigens* var. *uniflora*; a very common pioneer in sunlit areas. Whilst tolerant of a wide range in depth and organic content of sandy soils, it is generally in the poorer, more porous (and often shallower) soils (see Figs 17 and 18). It tolerates salt-spray and moderate winds. It responds to strong winds by being dwarfed and growing flat on the surface: generally it does not occur in the direct path of the extremely strong prevailing winds. Protected parts of this plant, particularly if lightly shaded, grow vigorously, at least during the summer; thus this plant not only stabilizes accumulating soils, but also contributes much organic material from its dried leaves.

In deeper, generally rather poor, sandy soils, even if this is merely in a rock fissure, *Sporobolus virginicus* is a very common pioneer in non-shaded situations. It is tolerant of stronger winds and more salt-spray than *G. rigens* var. *uniflora* or the *Paspalum vaginatum* mentioned below. Where subjected to excessive winds and salt-spray, if soil water is poorly supplied, *S. virginicus* also has a short growth-form but the shoots are upright.

Paspalum vaginatum occurs frequently mixed with *S. virginicus*. In places where heavy salt-spray or very strong winds occur over a prolonged period, *P. vaginatum* rather follows colonization by *S. virginicus* than occurs with it as a pioneer. However, where, because of topographical variation, these factors are not of major importance *P. vaginatum* may act as a pioneer on its own, particularly in shallow, moist or organically rich sandy soils. It also occurs frequently with *G. rigens* var. *uniflora*, but is more tolerant of wetter situations. In exposed places, when soil water is scarce, it grows very flat on the surface of the substrate.

The above three are the main vascular plant pioneers of open situations. Others which frequently come later in the plant succession may also occur as pioneer vascular plants where soil has been able to accumulate through protection by local topographical features and is organically

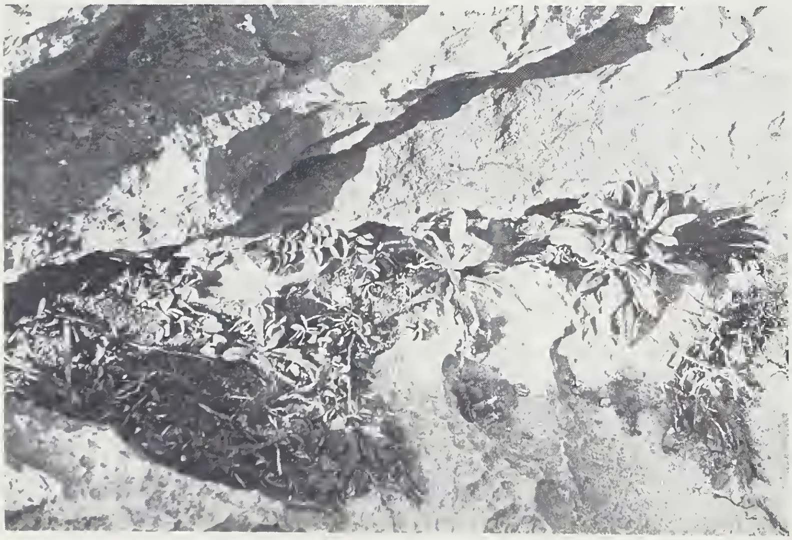


FIG. 18 - Pioneer plants in crevice and hollow in upper supralittoral rocks: *Gazania rigens* var. *uniflora* and smaller-leaved *Euphorbia livida*. Wind-blown debris and remains of earlier colonizers contribute to soil development. (Photo: A.W. Bayer)

enriched from wind-blown debris, from earlier algal colonization or, frequently, from earlier colonization by vascular plants which have been killed. In the last mentioned case these plants are secondary rather than primary pioneers. They are *Euphorbia livida* (common on the upper platform, where it may exist with its roots in very narrow fissures, sometimes horizontal, see Fig. 18); *Carpobrotus dimidiatus* (not tolerant of such small quantities of soil as is *E. livida); Tetragonia tetragonoides* (less frequent than the above two and occurs where water is more readily available); *Sonchus oleraceus* (often shaded, frequently invades mats of *Cladophora* sp. on mesoclinal faces in wider crevices, but where protected from strong winds).

Although the degree of severity of the adverse environmental factors varies, the main factors themselves are constantly present as long as sea-levels and the climate remain as they are. Therefore, although these pioneers in more favourable situations are capable of initiating further plant succession on the exposed supralittoral rocks, much of the succession is not able to go beyond the pioneer stages. In this particular regard, heavy trampling by man also halts succession. The three main primary pioneers are able to tolerate trampling to a degree, but further invasion is unable to take place. In response to the trampling factor, *Gazania rigens* var. *uniflora, Sporobolus virginicus* and *Paspalum vaginatum* have a very low growth form, not only because of the direct effect of trampling but also because of compaction and reduction of the soil (see Fig. 17).

Soil build-up is to be seen to only a very slight degree on the higher parts of the rocks (see Fig. 19) and in crevices not open to further removal by water below. In such situations several plants are able to invade the less unfavourable environment. Even if not protected directly by the above-mentioned pioneers,

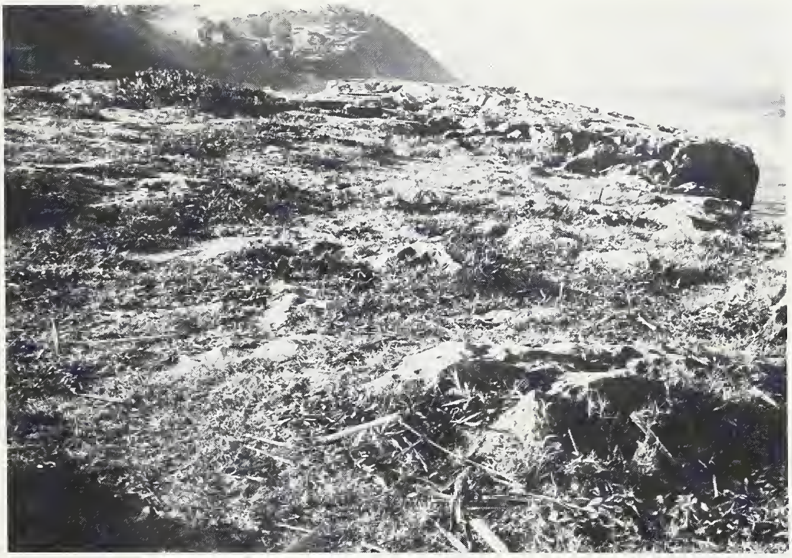


FIG. 19 - Windswept vegetation on upper platform of supralittoral rocks: *Paspalum vaginatum* dominant grass; *Gazania rigens* var. *uniflora* dominant forb

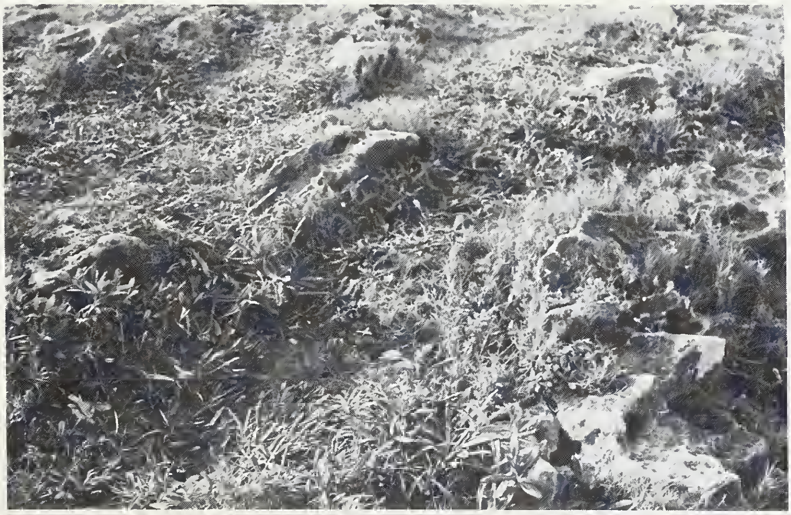


FIG. 20 - Low mixed herb community on exposed upper platform of supralittoral rocks. Grasses: *Sporobolus virginicus, Paspalum vaginatum, Stenotaphrum secundatum.* Forbs: *Gazania rigens* var. *uniflora, Asparagus densiflorus, Cynanchum obtusifolium, Helichrysum teretifolium*

they benefit indirectly from changes in the edaphic factors. In view of the severity of the environment, the invading plants do not necessarily oust the pioneers, but rather occur merely as associates in a low mixed herbaceous community (see Fig. 20).

One of the earlier plants to invade is *Asparagus densiflorus*. Sometimes this appears to be a pioneer when wind-blown organic debris and sand are able to collect in depressions. In most cases it follows initial colonization and, in exposed places, it may remain short enough not to offer severe competition to the pioneers (generally grasses), but, where protected, it generally shades out these plants.

Other early invaders requiring either protection from strong winds (which may be provided by the topography) or an improved or deeper soil are *Helichrysum teretifolium, Stenotaphrum secundatum, Euphorbia livida* (already mentioned as a pioneer in certain protected places), *Carpobrotus dimidiatus* (if the cover is very short), *Commelina erecta, Cynanchum obtusifolium, Osteospermum fruticosum* (in deeper or moister soils than those tolerated by the above-mentioned), *Aptenia cordifolia, Gloriosa superba, Droguetia urticaefolia, Asystasia gangetica* and *Barleria obtusa*. Occurring only occasionally and in well-drained or drier places are *Gladiolus gueinzii* and *Kalanchoe rotundifolia* var. *genuina. Chenopodium album* and *Physalis viscosa* occur in organically improved soils and are generally secondary. They both occur in places where they are protected from wind, but differ in their tolerance of shade. *C. album* occurs where it is not permanently shaded, such as in wide crevices, while *P. viscosa* frequently occurs where its wind-sheltered position is also lightly shaded.

Where environmental factors permit, woody plants and vines occur on these rocks following the plants mentioned above. Most of the woody plants are capable of direct invasion into short herbaceous vegetation where the pioneers are still important. Because of the adverse environmental factors in such places these woody plants are not capable of growing more than a few centimetres above the surface of the soil, other than temporarily when conditions are more favourable. Thus they, like the herbs already mentioned, are merely associates of the pioneers in a complex low climax community. Such woody plants are *Mimusops caffra, Carissa macrocarpa, Maerua nervosa, Eugenia capensis* and *Maytenus procumbens*. These are better developed in crevices receiving sunlight or, in the case of Tiger Rocks, on the landward side of the exposed rocks. In such situations, although they may be taller, their crowns are still kept level or nearly so with the rock platform because of severe wind pruning (see Fig. 21). Although all five are common, *Carissa macrocarpa* and *Maytenus procumbens*, sometimes with *Eugenia capensis*, are the more important here.

In addition, in such situations *Euclea natalensis, Rhoicissus digitata* and *Cyphostemma flaviflorum* also occur; the last mentioned sometimes spreads into the stunted herbaceous vegetation as well.

Where the woody plants are able to grow taller they form a closed dense canopy with no ground layer, especially in the crevices. Subordinate herbs are only those which climb or scramble; even pioneer grasses may extend into the closed canopy from the margin.

Of rare occurrence on these supralittoral rocks are *Ficus burtt-davyi* and *Phymatodes scolopendria*. The former occurs only where it is well protected from on-shore winds and, even then, it has a deformed and stunted growth form. The latter has been recorded only once: this had a stunted form although it was out of the path of the major winds and was fully shaded.

Fig. 22 gives an indication of the

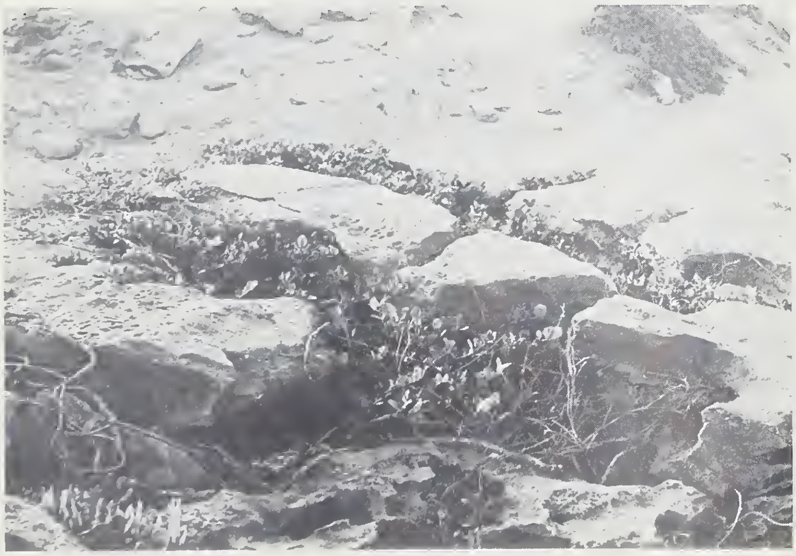


FIG. 21 - Effects of salt-spray-bearing winds. *Carissa macrocarpa* limited to depressions on exposed upper platform of supralittoral rocks

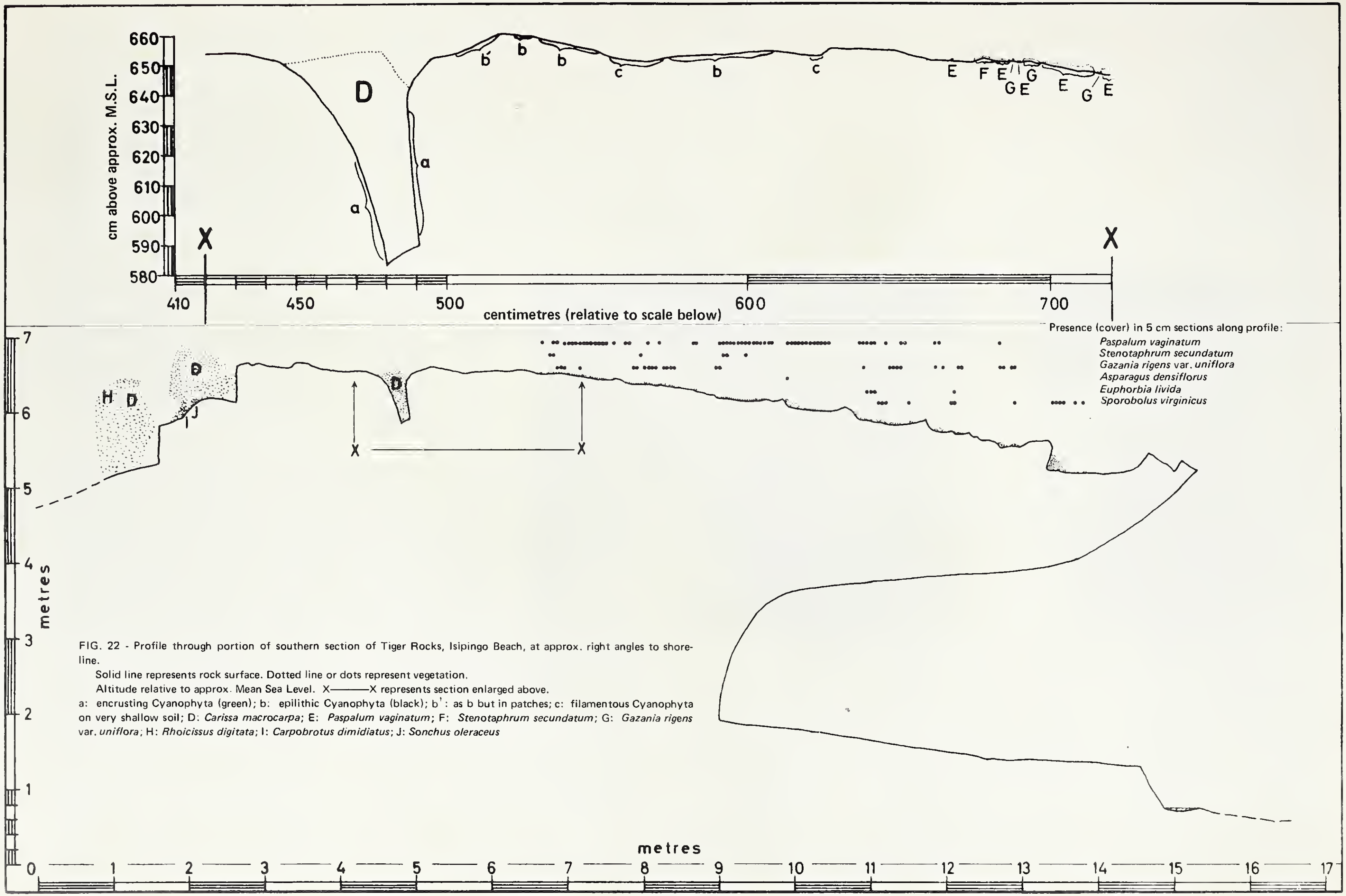


FIG. 22 - Profile through portion of southern section of Tiger Rocks, Isipingo Beach, at approx. right angles to shoreline.

Solid line represents rock surface. Dotted line or dots represent vegetation.

Altitude relative to approx. Mean Sea Level. X———X represents section enlarged above.

a: encrusting Cyanophyta (green); b: epilithic Cyanophyta (black); b': as b but in patches; c: filamentous Cyanophyta on very shallow soil; D: *Carissa macrocarpa*; E: *Paspalum vaginatum*; F: *Stenotaphrum secundatum*; G: *Gazania rigens* var. *uniflora*; H: *Rhoicissus digitata*; I: *Carpobrotus dimidiatus*; J: *Sonchus oleraceus* topographical and vegetational profiles through a section of Tiger Rocks where all stages except that of the succulent halophytes are able to be seen.

TABLE 12 - Relative frequency of vascular plants in shallow soil in hollows and small crevices on the upper windswept surface of the supralittoral rock platform at Tiger Rocks. (Based on presence in 250 quadrats 20 cm x 20 cm in a belt transect 10 m x 1 m at right angles to shore-line, altitude 6,6 m to 5,2 m above approximate mean sea-level)

Species	Relative frequency
Sporobolus virginicus	20,7
Stenotaphrum secundatum	16,1
Carissa macrocarpa	11,6
Maytenus procumbens	11,1
Paspalum vaginatum	8,5
Commelina erecta	7,9
Gazania rigens var. *uniflora*	6,8
Asystasia gangetica	5,0
Eugenia capensis	4,3
Asparagus densiflorus	3,8
Euphorbia livida	2,0
Maerua nervosa	1,7
Cynanchum obtusifolium	0,5
	100,0

Table 12 gives the Relative Frequency of vascular plants in a 1 m belt transect (10 m long) across the top of the rocks just north-east of the profile given in Fig. 22. Owing to slightly more broken topography than that shown in the profile diagram, woody plants, although extremely dwarfed, occurred over the full length with grasses and forbs.

4.1.3 Interrelationships of supralittoral rock plant communities

As mentioned earlier, the plant succession may not be able to proceed beyond the pioneer stages because of the constant presence of adverse environmental factors. However, where saline influence is minimal and where fresh water is able to be held, the succession may reach a low *Carissa macrocarpa - Maytenus procumbens* Scrub.

This low scrub is similar in composition to parts of the Closed Dune Scrub (p. 32) except that *Mimusops caffra* does not develop as a dominant on these rocks. This is the climax of the less severe situations, but any stage between those communities containing only non-filamentous Cyanophyta and this low scrub may be equally regarded as a local climax, depending upon the constancy of environmental factors operating in the particular situation.

Fig. 23 is a simplified outline of general plant succession on the supralittoral rocks. Seasonal retrogression may occur in the mesic or moister aspects when, through lack of rain, there is an increase in salt effect; or, through heavy storms, there is increased wave-splash or wind effect.

Control of the communities is both climatic and edaphic, aided in a few places by biotic control (trampling). Of major importance are the proximity of the sea, the frequency of strong winds and the short supply of freshwater. Interrelated with these factors is the inability of soil to accumulate in any great quantity on these rocks.

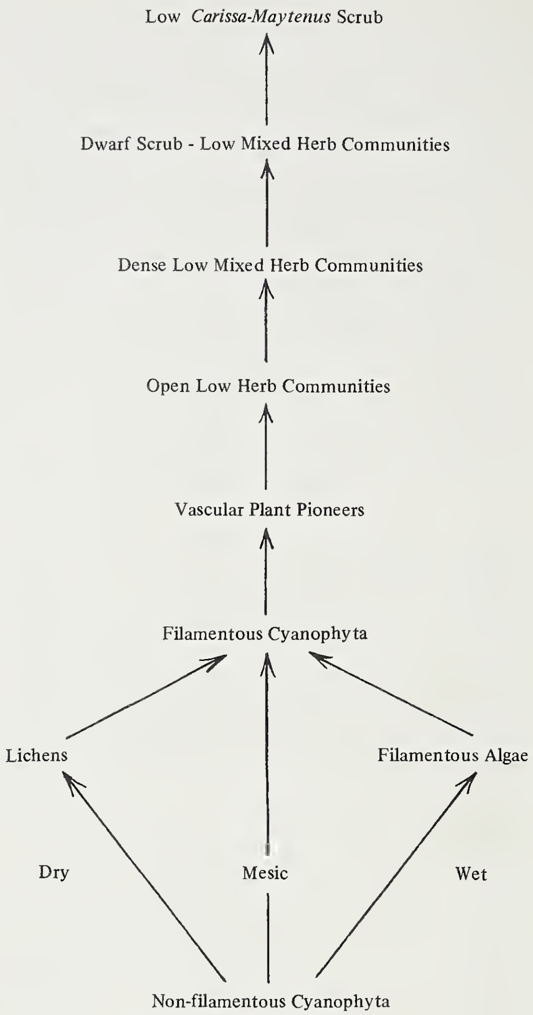

Low *Carissa-Maytenus* Scrub
Dwarf Scrub - Low Mixed Herb Communities
Dense Low Mixed Herb Communities
Open Low Herb Communities
Vascular Plant Pioneers
Filamentous Cyanophyta
Lichens
Filamentous Algae
Dry
Mesic
Wet
Non-filamentous Cyanophyta

FIG. 23 - Generalized community interrelationships on supralittoral rocks

4.2 PSAMMOSERE

Sands form the greater proportion of the substrate throughout the study area. The alluvial sands of the Flats and in the estuarine areas are dealt with in Sections 4.3 and 4.4. The sands in the remainder of the area are of two major types, differing in age, composition and topography. These are the younger white sands forming the modern dunes and the older red sands forming the main hills (see also Section 1.4). The vegetation on the two types is correspondingly different.

4.2.1 White sands (modern dunes)

Modern dunes occur along the present

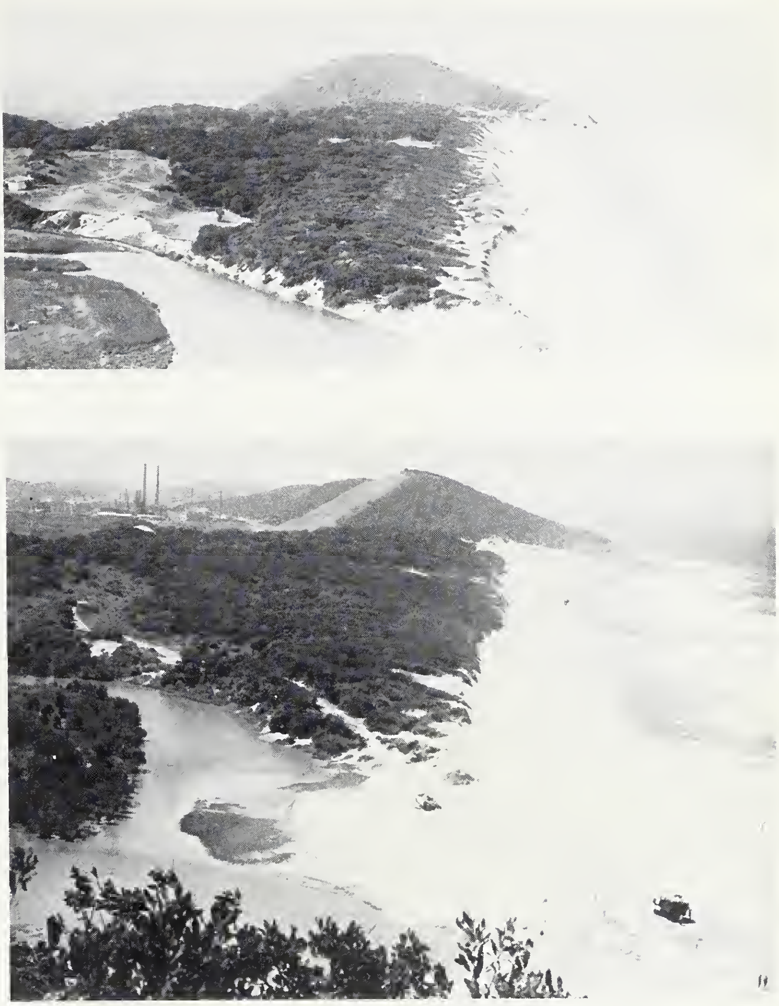


FIG. 24 - Changes in Isipingo North over a twenty-year period. Note in particular reduction of earlier dune communities and scrub encroachment in former golf course. (Photo: A.W. Bayer)

1949

1969

sea-shore, except where the higher supralittoral rocks occur, and they form all the higher parts of Isipingo North, except for Donsagolo Hill. Fig. 24 shows the greater part of the Isipingo North dunes and the main plant communities mentioned in this section. In the twenty-year period between the two photographs it may be noted that there has been considerable incutting by wave action into the early dune communities, with total removal of the pioneer communities. There is also a marked increase in secondary scrub and an advance of forest marginal trees into the grassed area representing an old, disused golf course.

4.2.1.1 PRISERE

When dried, after having been deposited on the shore by the sea, sand and shell fragments are subject to wind action. The on-shore winds blow the particles further inland and once this material is out of the direct influence of wave movement it is able to be colonized. Strand pioneers need to be able to tolerate the following adverse factors:

(i) extremes of temperature,
(ii) high insolation with reflected radiation from the white sands,
(iii) a porous substrate with a very low organic content,
(iv) an unstable, readily wind-blown substrate,
(v) abrasion and burial by wind-blown sand,
(vi) salt-spray and
(vii) a low freshwater supply .

Once any vegetation has become established, a dune is able to be built up: sand deposition and stabilization continues as long as the vegetation is living. This leads to marked changes in the environment and an increase in the number of plants able to invade. With a change in the topographical profile, differences between the environmental factors affecting the leeward and windward sides become intensified. These micro-environmental differences are accentuated by the local trend of the coastline and by the fact that the strongest winds are from the southern sector. Briefly, the inland (leeward) slopes are steeper, they receive more insolation (see Section 2.1 and Table

2) and the sand is less compact than the seaward side which, however, receives more direct wind, more salt-spray and an increased chance of sand-abrasion.

4.2.1.1.1 Pioneer strand communities

Arctotheca populifolia, whilst common as a strand pioneer in several places along the south and north coasts of Natal, has been recorded only once by the author in the study area. This was an ephemeral establishment (approximately two months duration) in sand close to the edge of the Mbokodweni Lagoon where it would have received considerably more fresh water than in other places along the local strand.

The more general pioneer in loose beach sand in the study area is *Hydrophylax carnosa*. This low-growing succulent responds readily to being buried by sand by an increase in the rate of elongation of the horizontal stem and in the length of the normally short side branches. Thus the amount of fixed sand becomes greater, although more horizontally than vertically, with the result that low rounded dunes are formed. It is not only sand which collects on these mounds but also wind-blown organic material including disseminules of other plants.

Scaevola thunbergii which is frequently a pioneer in itself, generally invades *H. carnosa* dunes. It becomes established either on the low dunes or between collections of these where a reduction in wind velocity prevents further rolling of its fruit (see Fig. 25). Once established, being taller, this shades out *H. carnosa* and, for the same reason, reduces wind velocity even more than *H. carnosa* does. It responds to burial by an increase in the rate of elongation of its stems and in the production of adventitious roots. This results in the formation of larger and higher dunes since the stems are generally ascending or vertical (unless excavation has occurred). Buried leaves separate from the stem after shrivelling, thereby adding to the organic content of the soil. This shrivelling is due to resorption of food material and water (Hillary, 1947), thus there is a conservation of these substances - a feature displayed by other local leaf succulents as well.

Invading stabilized sand, either competing directly with *Hydrophylax carnosa* or coming into the more open parts of *Scaevola thunbergii* stands, are *Launaea sarmentosa, Gazania rigens* var. *uniflora, Canavalia maritima, Ipomoea pes-caprae* and *Carpobrotus dimidiatus*. All of these are tolerant of salt-spray to a degree, but not of all the other factors to which the initial strand pioneers are subjected. *L. sarmentosa* and *G. rigens* var. *uniflora* are frequently directly in the salt-spray on the windward side of the dunes (see Fig. 26), thus they probably derive the greatest benefit from mere stabilization. Nevertheless, the improved soil water conditions no doubt aid both; more particularly *G. rigens* var. *uniflora*, since *L. sarmentosa* occurs frequently on less compacted sand in drier situations, but not where the sand is subjected to much movement. *C. maritima* and *I. pes-caprae* are generally rooted in the more stabilized and improved soils and, whilst they sometimes extend into salt-spray, they are better developed where this is reduced. Thus they occur more plentifully on the inland sides of these dunes where they frequently extend out and cover bare patches of sand. *Carpobrotus dimidiatus*, although a succulent, is best developed where the soil water relations have been improved.

Sporobolus virginicus occasionally occurs with *Scaevola thunbergii*, exposed to wind and salt-spray, but is not shade-tolerant. This is frequently subseral, coming into sand that has been blown on to previous vegetation (see Fig. 13), or in low-lying beach sand near the estuaries where it may form low dunes on its own.

On the leeward side of the *Scaevola* dunes other herbs occur. These are, in order of frequency, *Tephrosia purpurea* subsp. *canescens* in open situations, *Gladiolus gueinzii* generally with *S. thunbergii, Cyperus natalensis* (which becomes a very important stabilizer in disturbed sand out of the direct strong on-shore winds or where the sand has improved water relations) and *Eulophia speciosa* which is rare and generally occurs only in improved soils or in low-lying situations.

These above-mentioned herbs are subordinate to *S. thunbergii* and, with their establishment,

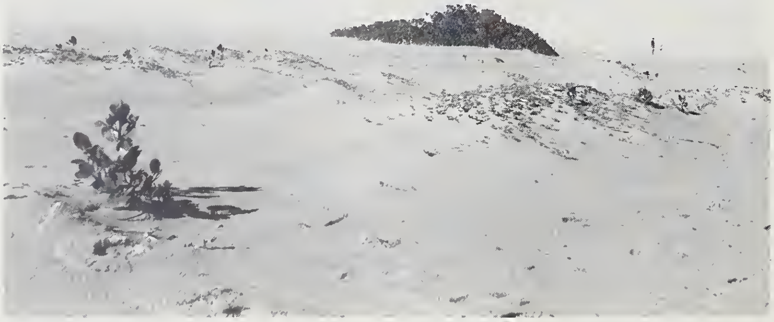
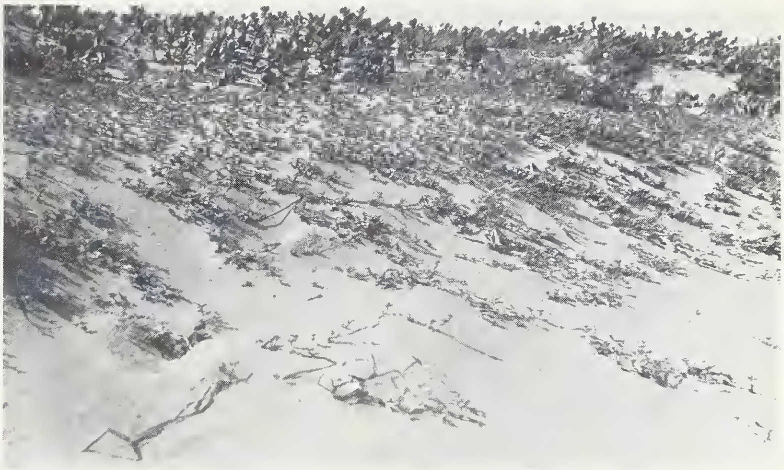


FIG. 25 - Early colonization of strand. Low dunes fixed by *Hydrophylax carnosa* with young *Scaevola thunbergii* invading. Older *S. thunbergii*-fixed dune in background

FIG. 26 - Later stage in dune fixation. *Hydrophylax carnosa* in foreground invaded by *Gazania rigens* var. *uniflora* and, to lesser degree, by *Launaea sarmentosa*. *Scaevola thunbergii* dominant in background. (Photo: B Cuffley)



provide a better cover to the substrate.

Gazania rigens var. *uniflora*, in particular, followed by *Carpobrotus dimidiatus* and in places by *Cyperus natalensis*, is an important pioneer of loose beach sand that has recently been blown on to the base of the steep seaward facing hills. The succession that follows in this case is dealt with under Section 4.2.2.1.1.1.

Woody plants, invading later, compete directly with *S. thunbergii* which is then shaded out except where aided by persistent environmental factors adverse to the invaders.

4.2.1.1.2 Open Dune Scrub

The first shrub to invade open situations where the soil is generally loose and poor is *Passerina rigida*. Although tolerant of light salt-spray, it is killed when this is excessive, as may happen following exceptional storms or disturbance to the vegetation or the dunes on its windward side. Furthermore *P. rigida* is an obligate heliophyte. Therefore it will occur only in the open places or on the inland facing slopes where insolation is high (see Fig. 27). It, however, casts sufficient shade to oust *S. thunbergii* and its heliophilous subordinates (see Table 3 for Light Intensities under different dune communities).

In the more improved soils, thus generally in troughs directly protected by *S. thunbergii*, other shrubs are able to invade. The earlier of these are *Chrysanthemoides monilifera* subsp. *rotundata* and *Eugenia capensis*. The former is a brittle-stemmed shrub which is not tolerant of the extremely strong on-shore winds. This, too, gives way to the more umbrageous shrubs, including *E. capensis*. The latter is more salt-tolerant, but it still becomes markedly hedged where it is exposed to on-shore winds.

Associated with these are *Maytenus procumbens, Mimusops caffra, Maytenus nemorosa, Euclea natalensis, Sideroxylon inerme* and, occasionally, *Aloe thraskii* (more common where soils are not so porous). These may occur isolatedly or in small mixed clumps and, occasionally, in more protected places, *Barleria obtusa* occurs marginal to these. Also occurring occasionally in these clumps is a holoparasite, *Hyobanche fulleri*, recorded on the roots of *Chrysanthemoides monilifera* subsp. *rotundata*.

Figs 28 and 29 give data for a line and a belt transect, respectively, through the younger dune communities. The steepness of the seaward slope, shown in Fig. 28, was due to undercutting by heavy seas six months prior to the date of the investigation.

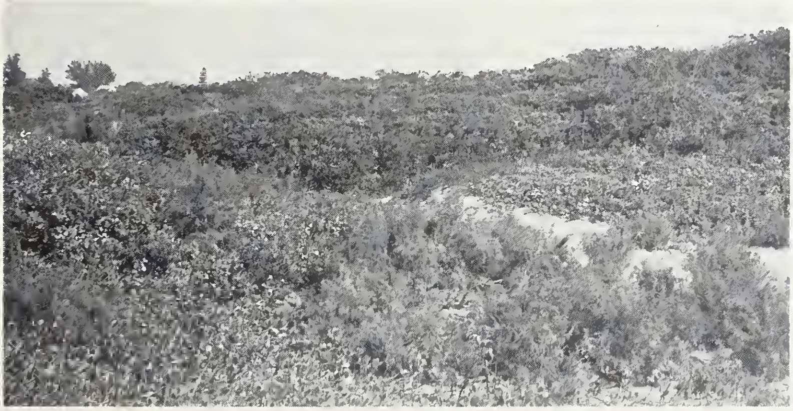


FIG. 27 - Open Dune Scrub. *Scaevola thunbergii* being ousted by *Passerina rigida* (mainly to right); *Chrysanthemoides monilifera* subsp. *rotundata* (centre and left middle distance); *Eugenia capensis* (left middle distance). *Mimusops caffra* dominant in Closed Dune Scrub in background. Note low form of *M. caffra* and *Maytenus procumbens* stabilizing wind-blown sand at disturbed margin of closed scrub. (Photo: A.W. Bayer)

4.2.1.1.3 Closed Dune Scrub

The shrubs mentioned above compete directly with *S. thunbergii* on the leeward side of the original dunes and with *P. rigida*. This leads to the development of a closed mixed scrub with a very dense, generally complex canopy, hedged above by the strong on-shore winds.

Although this is a mixed scrub, *Eugenia capensis* and *M. procumbens* are particularly common at first. Associated with these are the woody members of the open scrub together with *Carissa macrocarpa, Brachylaena discolor, Tricalysia sonderana, Apodytes dimidiata* subsp. *dimidiata* and *Maerua nervosa*.

Asystasia gangetica and *Gloriosa superba*, in places, occur as marginal herbs.

Climbers are well represented and include *Cynanchum obtusifolium, Scutia myrtina, Rhoicissus digitata, Rhus nebulosa, Cyphostemma flaviflorum, Rubia cordifolia, Ipomoea ficifolia* and *Tragia durbanensis*. The first four mentioned sometimes spread into the open communities but remain rooted in the closed scrub. Adding to the complexity of the dense canopy of this scrub are dune plants (*Canavalia maritima* and *Carpobrotus dimidiatus*) which sometimes spread across the top of the canopy.

Due to upward deflection of the salt-spray bearing winds by the dunes and the scrub marginal plants, the height of the canopy increases with distance from the seaward margin. The height is dependent upon the salt-spray factor and not directly on the topographical profile. Thus this vegetation has a characteristically even profile, rising steadily landwards, and with taller plants in the troughs between the dunes.

With an increase in height of the canopy there is a change in composition. Those plants such as *Chrysanthemoides monilifera* subsp. *rotundata* and *Aloe thraskii* are ousted. Some plants become relatively more slender (for example *Maytenus procumbens*), others increase in size (for example *Mimusops caffra*). Additional associates are *Canthium obovatum, C. inerme, Pavetta revoluta* and *Cassine papillosa*. Subordinate shrubs make their appearance, and include *Carissa bispinosa* var. *acuminata, Peddiea africana* and *Psychotria capensis*. A field layer is able to become established on the litter-rich shaded sands, albeit rather sparsely so at first. Members of this initial field layer are *Asparagus densiflorus, Berkheya maritima, Panicum deustum, Phymatodes scolopendria, Isoglossa woodii* and *Haemanthus puniceus*.

Cyphostemma hypoleucum, Heliophila scandens, Secamone alpinii and *Cynanchum ellipticum* are climbers additional to the earlier list.

4.2.1.1.4 *Mimusops caffra* Woodland

Further landwards, as the canopy increases in height, trees become the dominant growth form. With canopy trees of 6-7 m in height, this community, then, ceases to be a scrub in the strict sense of the term, but it lacks the stratification and increased complexity of a forest.

The canopy is still mixed, but *Mimusops caffra* becomes the most numerous of the larger trees, although *Euclea natalensis* and *Sideroxylon inerme* are also very common. Associates of these are *Canthium obovatum, Apodytes dimidiata* subsp. *dimidiata, Cordia caffra, Maytenus nemorosa, Allophylus natalensis, Brachylaena discolor, Cassine papillosa* (generally subordinate) and, rarely, *Strelitzia nicolai*.

Sub-canopy trees or shrubs which sometimes occur directly in the canopy on the higher and steeper seaward slopes include all of those already mentioned under Closed Dune Scrub, as well as *Deinbollia oblongifolia* and *Turraea floribunda*.

Lower shrubs include *Peddiea africana, Carissa bispinosa* var. *acuminata, Psychotria capensis, Acokanthera oblongifolia, Turraea obtusifolia, Putterlickia verrucosa* and, where the canopy is lighter or open, *Maerua nervosa*.

In the field layer, *Isoglossa woodii* becomes increasingly more abundant and, although showing marked periodicity in development (see Check-list), it becomes the dominant of this synusia. Additional members, apart from those mentioned for Dune Scrub, are *Laportea peduncularis, L. grossa, Dietes vegeta, Sansevieria hyacinthoides, Dracaena hookerana, Crocosmia aurea, Cyperus albostriatus, Droguetia urticaefolia* and *Australina acuminata*. Where the canopy is open, *Pupalia atropurpurea*, generally somewhat scandent, and *Panicum chusqueoides* frequently occur.

Climbers and scrambling shrubs are numerous. Included in this synusia are *Scutia myrtina, Rhus nebulosa, R. natalensis, Grewia occidentalis, Cyphostemma hypoleucum* (which becomes increasingly more common away from the seaward margin of the Dune Scrub), *C. flaviflorum* (which becomes less frequent away from Dune Scrub), *Rhoicissus tomentosa, R. rhomboidea, Heliophila scandens, Secamone alpinii, Cynanchum ellipticum, Embelia ruminata, Dioscorea sylvatica* var. *paniculata*. *Behnia reticulata, Pyrenacantha scandens, Gloriosa superba, Ctenomeria capensis, Thunbergia dregeana, Dioscorea crinita* and *Smilax kraussiana* are low climbers, not reaching the upper canopy, and the latter five occur where the canopy is not completely closed.

Ficus burtt-davyi occurs in the canopy as a rambling hemi-epiphyte. *F. vogelii* and *F. natalensis* are also hemi-epiphytes occurring occasionally in this community but are not salt-tolerant.

This community represents a more mature stage than Dune Scrub in the succession to Dune Forest. The canopy is still hedged by salt-spray-bearing winds and the substrate lacks the depth of organic material found in the more mature forest.

4.2.1.1.5 Dune Forest

This develops on the white sand dunes where there is protection from salt-spray-bearing winds,

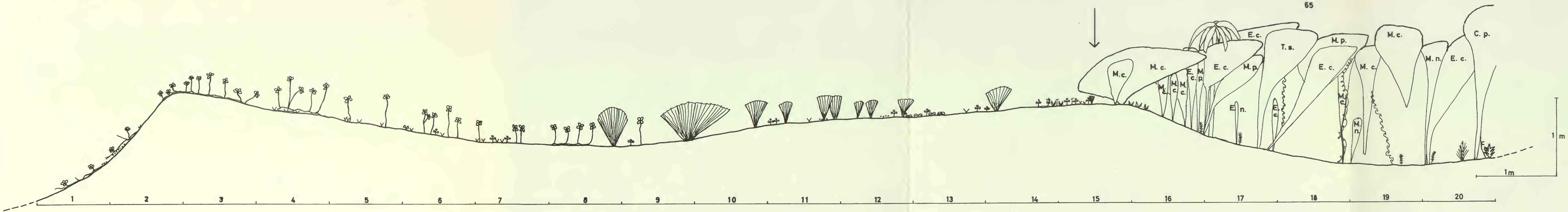


FIG. 28 - Profile through early dune communities, Isipingo North, at right-angles to shore-line. Data from 30 cm transect except to right of arrow where data for woody plants from belt 90 cm wide, data for herbs still from 30 cm belt. Apex of seaward dune approx. 6.5 m above mean sea-level. 1 - 20 represent stations depicted in histograms below (Fig. 29)

KEY:

...... *Hydrophylax carnosa*
Scaevola thunbergii
Launaea sarmentosa
Canavalia maritima
Ipomoea pes-caprae
Passerina rigida
Gazania rigens var. *uniflora*
Tephrosia purpurea subsp. *canescens*
Carpobrotus dimidiatus
Aloe thraskii
Asparagus densiflorus
Scutia myrtina
Phymatodes scolopendria
Rhoicissus digitata
Panicum deustum
Cyphostemma flaviflorum
M.c. *Mimusops caffra*
E.c. *Eugenia capensis*
M.p. *Maytenus procumbens*
E.n. *Euclea natalensis*
T.s. *Tricalysia sonderana*
M.n. *Maytenus nemorosa*
C.p. *Cassine papillosa*

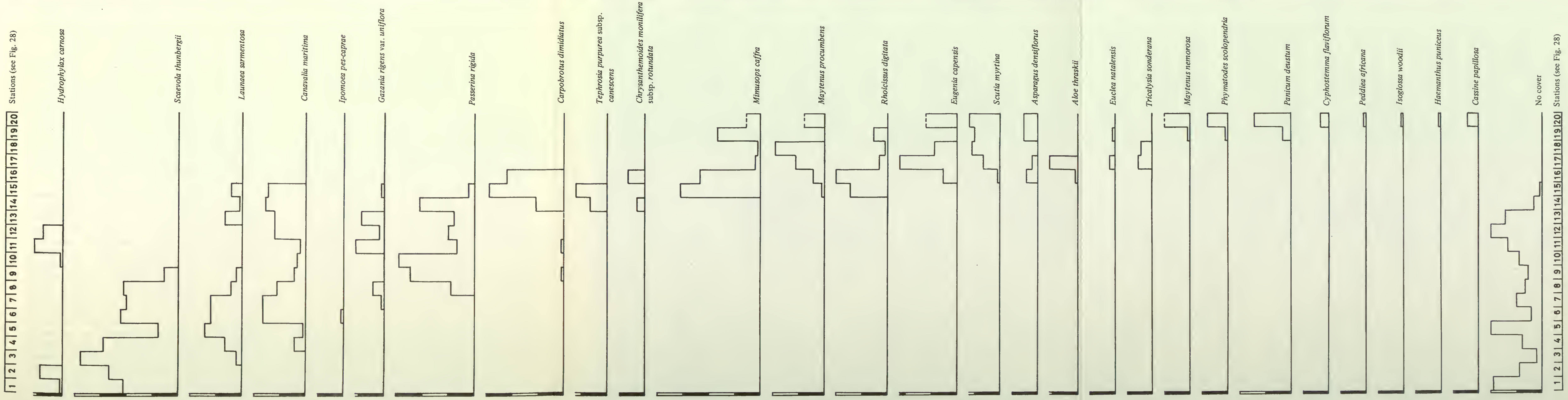


FIG. 29 - Distribution of dune plants, based on absolute values of cover frequency, in belt transect adjacent to profile shown in Fig. 28. Data from presence in 36 quadrats, 30 cm x 30 cm, at 20 stations 180 cm x 180 cm. Lowermost histogram represents number of quadrats in which no plants at all were recorded. One division of vertical scale represents 25 per cent frequency. Values for some species (shown by broken line) in Station 20 only approximate due to complexity of canopy

or, at least, where these are very much reduced, and where there is an improvement to the substrate. Although a good layer of litter and humus develops on these dunes under the more mature vegetation, the subsoil is still very porous (see Section 1.4). Owing to this porosity and the fact that the landward side of these dunes is much lower in altitude than are the dunes themselves, the vegetation, in the main, has to rely on direct precipitation for its fresh water supply. Consequently the greater direction of root growth, in general, is horizontal and shallow. The topographical profile within the forest is very uneven, especially in the northern parts where, in addition to dunes up to just over 30 m in altitude, there are depressions as low as just under 6 m above sea-level. The direct and indirect effect of this is reflected in the height of the canopy, as described later.

In the southern section of the Isipingo North dunes (Fig. 30), where the topographical profile is more gentle and the seaward dunes are lower, a transitional zone between *Mimusops caffra* Woodland and Dune Forest is more clearly exhibited than is the case in the north-eastern section. In the more uneven north-eastern section where high dunes occur close to the strand, transition is more abrupt, and even the woodland is shorter and more scrub-like on the higher seaward slopes.

(A) TRANSITIONAL ZONE - The plants of this community are, with a few changes, those already-mentioned members of the *Mimusops caffra* Woodland together with many additions in all synusiae above the field layer.

Initially *M. caffra* is the dominant tree, but it loses this status through invasion by other trees. However, it remains an important member particularly on ridges, even in mature forest.

In regard to changes in the canopy trees mentioned under *M. caffra* Woodland, *Maytenus nemorosa* becomes a subordinate slender tree; *Allophylus natalensis* and *Brachylaena discolor* are not tolerant of deep shade and, unless there is a disturbance, these do not occur in the Dune Forest proper. *Cassine papillosa* occurs as a slender shrub while *Strelitzia nicolai* is restricted to woodland.

The canopy of this early forest is discontinuous and the height varies with topography. The tallest trees, occurring rather as emergents 7-8,5 m tall, are *Mimusops caffra, Sideroxylon inerme, Canthium obovatum, Apodytes dimidiata* subsp. *dimidiata, Euclea natalensis*, rarely *Brachylaena discolor* and, possibly as a relict of very early disturbance, *Clausena anisata* (up to 7,6 m tall). In troughs between dunes or on the leeward of dunes and protected by the more salt-spray-tolerant members are *Scolopia zeyheri, Linociera peglerae* and *Olea woodiana*. Other trees of the upper canopy, but not occurring as emergents, include *Cordia caffra, Fagara capensis, Clerodendrum glabrum, Bersama lucens, Teclea gerrardii, Eugenia natalitia, E. capensis* and, rarely, *Erythrina lysistemon*. Where the canopy is shorter, *Maytenus nemorosa* and, occasionally, *Xeromphis obovata* occur also.

The subordinate small tree and shrub strata, in addition to those members already mentioned under *Mimusops caffra* Woodland, include *Dovyalis rhamnoides, D. longispina, Ochna natalitia, Diospyros natalensis, Erythroxylum emarginatum, Drypetes natalensis* and *Suregada africana.*

There is little change in the specific composition of the overall field layer, except for the rare addition of *Asparagus africanus*. However, with increased shade effects and more organic material in the soil, there are differences in distribution and relative frequency of individual species.

Climbers are particularly well represented and include all of those mentioned for Dune Forest proper, with the exception of *Cissampelos torulosa, Senecio brachypodus, S. deltoideus* and *S. helminthoides* which come in later.

Cyrtorchis arcuata occurs as an epiphyte on inland-facing slopes. Hemi-parasites, *Loranthus kraussianus* and *L. dregei* are frequent.

With invasion by additional dominants (initially *Celtis africana* and *Podocarpus latifolius*, in troughs between the dunes, followed by other species), and generally accompanied by an increase in canopy height, this becomes Dune Forest proper.

(B) FOREST PROPER - The dominant tree layer forms an uneven canopy with the larger specimens occuring as emergents. As already mentioned, the height of the canopy varies with variation in the topography. On the higher ridges it may be as short as 5,5 m, but in the valleys the canopy is taller, up to 13,7 m, with emergents up to just over 15 m tall.

Mimusops caffra is represented by only a relatively few large specimens in the upper canopy in the more mature parts, but it is common and occurs as an emergent on the ridges. The tallest living specimen of this species recorded was 11,6 m tall.

In addition to *M. caffra*, the following are common members of the upper canopy which occur as emergents where the effect of on-shore winds is minimal. The figure given in brackets is the maximum recorded height and the presence of an asterisk* indicates that the species is deciduous to a degree (see note below).

* *Celtis africana* (15,2 m)
Podocarpus latifolius (12,5 m)
* *Strychnos decussata* (14,3 m)
* *S. madagascariensis* (12,2 m)
Sideroxylon inerme (13,7 m)
Olea woodiana (12,8 m)
* *Ficus vogelii* (13,7 m)
* *Cordia caffra* (12,2 m)
Canthium obovatum (12,0 m)
* *Ziziphus mucronata* (12,2 m)

Aspect determines not only height, but also distribution of the dominants, in particular that of the emergents. Those that are not tolerant of salt-spray develop to their maximum height only where protected from this factor. These plants are primarily the deciduous species which, however, exhibit various degrees of deciduousness. Fully deciduous for the greatest length of time is *Celtis africana*, followed by *Cordia caffra*. *Ficus vogelii, Strychnos decussata* and *S. madagascariensis* are briefly deciduous (the latter two particularly briefly). *Ziziphus mucronata* in this area is seldom fully deciduous: leaf loss and gain generally occur simultaneously. Of these, *Celtis africana* is the least salt-spray tolerant. It is readily hedged by even light on-shore winds and if salt-spray is increased, as may happen after disturbance, this tree dies earlier than others in this community. Apart from those listed earlier as members of the upper canopy of the seral communities, *Podocarpus latifolius* would appear to be most salt-tolerant of the above list. In addition to its occurrence in protected valleys, it also occurs on higher ridges subjected to on-shore winds. However, in such places, it is generally only shortly emergent with a wind-trained crown. Furthermore, on the side from which the strongest winds blow, there is generally some form of protection, topographical or vegetational (usually *Mimusops caffra*).

Emergents of rare occurrence in this Dune Forest are *Euphorbia ingens* (6,7 m) in short forest on the summit of a high dune and *Cussonia sphaerocephala* (9,1 m), of which only one specimen was recorded, out of the direct path of on-shore winds.

Other members of the upper canopy which are only occasional emergents include *Chaetachme aristata* (13,7 m), *Eugenia natalitia* (12,2 m), and *Scolopia zeyheri* (11 m). Those which fall even less frequently into the category of emergents, yet are members of the upper canopy include:

Linociera peglerae (11 m)
Canthium inerme (9 m, generally subordinate)
Clausena anisata (7,6 m, generally subordinate)
Clerodendrum glabrum (9 m)
Commiphora harveyi (6,1 m)
C. woodii (10,5 m, inland lower parts)
Diospyros natalensis (10,5 m, generally subordinate)
Euclea natalensis (10,7 m)
Eugenia capensis (8,5 m, rare in forest proper)
Fagara capensis (8,5 m)
Ficus natalensis (8 m, rare)
F. burkei (9,8 m, rare, only inland and lower-lying)
Mimusops obovata (9,5 m, generally subordinate)
Teclea gerrardii (10,7 m, frequently subordinate)

The subordinate tree layer is well developed where the upper canopy is tall but where this is short it merges with the shrub layer. In addition to those mentioned above, which sometimes occur as upper canopy trees, but are more generally subordinate, taller trees (6-10 m) include:

Cola natalensis
Drypetes natalensis
Erythroxylum emarginatum
Baphia racemosa
Cassipourea gerrardii
Cussonia nicholsonii (occasional)
Deinbollia oblongifolia
Dovyalis longispina
Maytenus nemorosa
Turraea floribunda

Smaller trees and shrubs, 1-3(-6) m tall are:

Acokanthera oblongifolia (occasionally up to 6,1 m tall)
Carissa bispinosa var. *acuminata*
Dracaena hookerana
Dovyalis rhamnoides
Gardenia thunbergii (rare)
Kraussia floribunda
Monanthotaxis caffra (generally scandent)
Ochna natalitia
Pavetta revoluta (where canopy light and short)
Peddiea africana
Psychotria capensis
Putterlickia verrucosa
Rhus natalensis (generally scandent and canopy open or short)
Suregada africana
Turraea obtusifolia
Urera cameroonensis (scandent)
Uvaria caffra (also scandent)
Vangueria chartacea

The field layer is dominated by *Isoglossa woodii* which is best developed where it is lightly shaded and fully protected from wind. In such situations it forms an extensive and dense cover with stems up to 4,1 m tall. However, this dies after mass flowering in approximately 10-year intervals (see Check-list).

Few plants are able to tolerate either the dense shade cast by this plant (see Table 3) or that where conditions were too shaded for the establishment of *I. woodii* in the first place. Thus, in general, the field layer is poorly represented. Those plants tolerant of deep shade include *Sansevieria hyacinthoides, Haemanthus puniceus* and *Asplenium prionitis*. Where organic material

FIG. 30

1. Uncolonized, unstable beach with steep banks on inland side incut by high seas; pioneer communities absent
2. Closed Dune Scrub: note continuous canopy showing direction of wind (as does also any disturbance)
3. Dune migrating inland following earlier disturbance to vegetation, now being stabilized mainly by *Scaevola thunbergii*
4. Mixed shrubs invading World War II Campsite
5. *Mimusops caffra* Woodland
6. Dune Forest (Transitional)
7. Dune Forest (Proper)
8. Grassland (former golf course) invaded by *Lantana camara* dominant scrub
9. *Brachylaena discolor - Mimusops caffra* thickets (later stages in succession to forest)
10. *Cymbopogon excavatus* dominant grassland

Also shown: 11. Mangroves. 12. Halophilous grassland. 13. *Phragmites australis* Consocies. 14. *Hibiscus tiliaceus* Communities. 15. Low-lying mesophytic grassland. 16. Low-lying mesophytic scrub communities. 17. Low-lying mesophytic woodland - early forest communities

Approx. 100 m

Scale approx. 1:3 000

5 Contours in approx. 5 m intervals

Arrow indicates true North

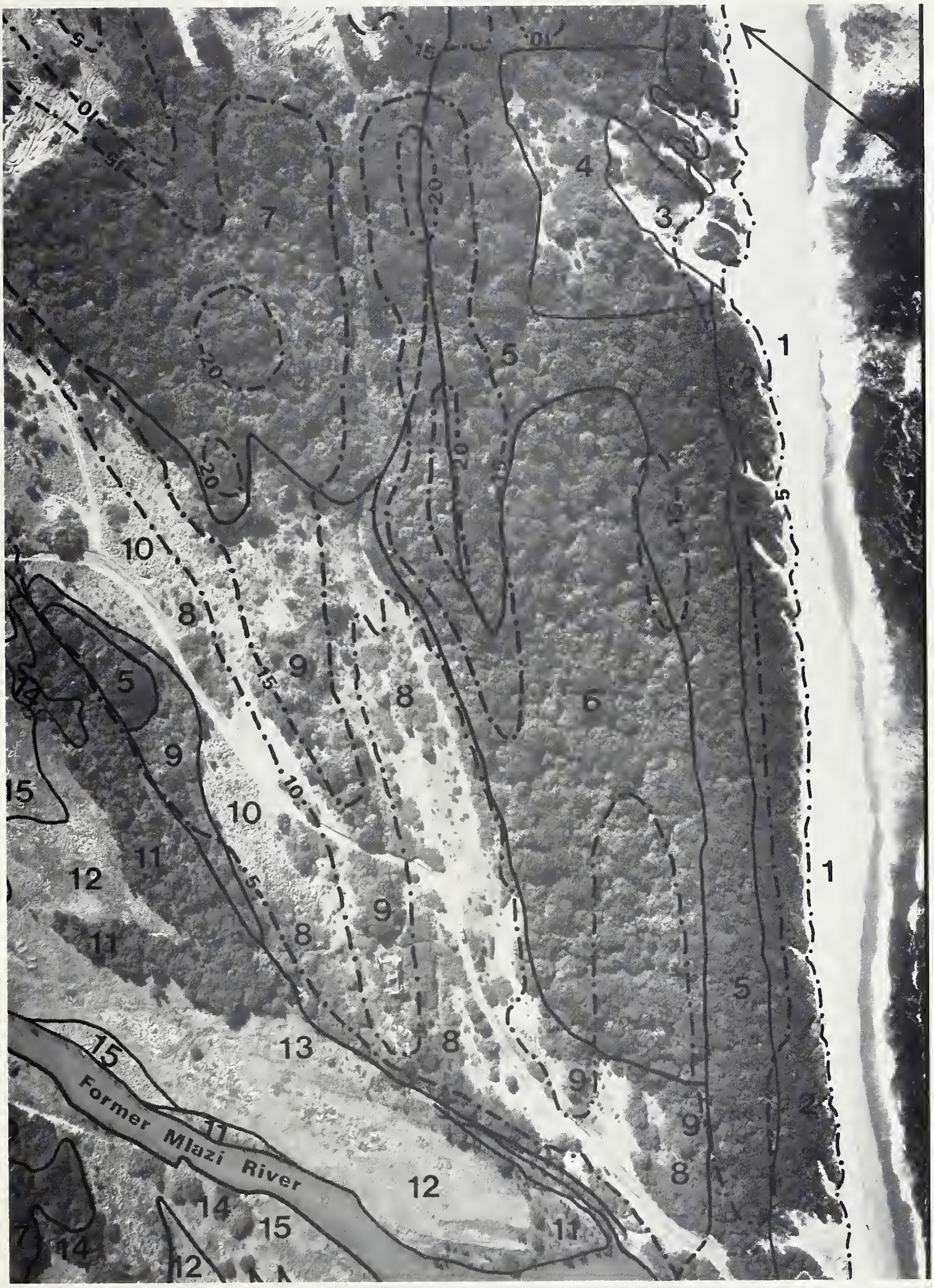


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FIG. 30 - Southern portion of Isipingo North white sand dunes in June, 1969, immediately prior to destruction of all but more seaward communities

on the substrate is well accumulated, *Haemanthus albomaculatus* occurs in the field layer. Other members of the field layer with more general distribution and in lighter shade are:

Achyranthes aspera (light shade)
Anomatheca laxa (very light shade)
Asparagus africanus (rare)
A. densiflorus
Australina acuminata
Berkheya maritima
Chlorophytum modestum
Crocosmia aurea
Dactyloctenium australe (very light canopy)
Dicliptera heterostegia
Dietes vegeta
Laportea grossa
L. peduncularis
Panicum chusqueoides (light shade or marginal)
P. deustum
Plectranthus ambiguus
P. verticillaris

There is no ground layer apart from saprophytic fungi on litter, which were not studied.

Climbers are particularly well represented, especially where any disturbance has occurred. Many are woody and occur in the upper canopy where they add considerably to the shade cast by this stratum. Included in this synusia are the following (C = lianous upper canopy species):

Acacia kraussiana (C)
Adenia gummifera var. *gummifera* (C)
Allocassine laurifolia (C)
Asparagus falcatus
A. setaceus
Behnia reticulata
Capparis brassii (C)
C. sepiaria var. *citrifolia* (C)
C. fascicularis var. *zeyheri* (C)
Cissampelos torulosa
Cissus fragilis
Ctenomeria capensis
Cynanchum ellipticum
C. natalitium
C. obtusifolium
Cyphostemma hypoleucum (C)
Dalbergia armata (C)
Dalechampia capensis (lightly shaded)
Dalbergia obovata (C)
Dioscorea cotonifolia
D. sylvatica var. *paniculata*
Embelia ruminata (C)
Flagellaria guineensis (C)
Grewia caffra (C)
G. occidentalis (C)
Heliophila scandens
Ipomoea congesta
Monanthotaxis caffra (C)
Pyrenacantha scandens
Rhoicissus rhomboidea (C)
R. tomentosa (C)
Rhus natalensis (C)
R. nebulosa (C)
Scutia myrtina (C)
Secamone alpinii
Senecio brachypodus (xeroclines)
S. deltoideus (mostly marginal)
S. helminthioides
S. tamoides
Thunbergia dregeana
Uvaria caffra (C)
Vernonia angulifolia

Hemi-epiphytes are represented by the following *Ficus* spp. *F. burtt-davyi* seldom completely strangles its support but, gripping various trees, it extends into the upper canopy as a scrambler; it also occurs abundantly as a shrub in disturbed places.

F. vogelii is common and, partly or completely strangling its original support, it eventually becomes a member of the dominant tree layer, as already mentioned.

F. natalensis and *F. burkei* also occur as stranglers, eventually occurring as independent trees into the upper canopy, but are rare.

True epiphytes are frequent. The most widespread of the vascular plants is *Cyrtorchis arcuata*. Others include *Polystachya sandersonii, Mystacidium venosum, Tridactyle bicaudata* and *Microsorium punctatum*. *M. punctatum*, a nest-epiphyte, is tolerant of more shade than the others and it frequently occurs terrestrially (where not too dry) having fallen with its support which may decay before *M. punctatum* eventually dies.

Vascular plant parasites are represented by hemi-parasitic Loranthaceae: *Loranthus quinquenervis* (canopy, out of direct path of on-shore winds), *L. dregei, L. kraussianus* (mostly marginal or where disturbed) and *Viscum nervosum* (canopy on higher ridges).

4.2.1.2 SUBSERES

4.2.1.2.1 Disturbed seaward dune communities

Environmental improvement and plant succession as described in Section 4.2.1.1 are dependent upon the continued stabilization of the seaward dunes. Whilst the pioneers are capable of fixing wind-blown sand, they are not able to prevent undercutting by wave action. Storm waves frequently remove sand and its vegetational cover (see Fig. 7). Depending upon the amount of destruction of the pioneers and the steepness of the altered topographical profile, such incutting has further repercussions in various degrees of severity on the topography and vegetation on the landward side of the disturbance.

If the undercutting is not too severe, but causes a reduction in the height of the crest of the seaward dunes, salt-spray and wind are then able to reach formerly protected plants. The exposed parts are generally killed, but, if sufficient protection is still present below, the woody plants of the Dune Scrub (except for *Passerina rigida*) generally coppice from the base (see Fig. 27). This produces a lower and more compact seaward margin to the exposed scrub than is the case under ordinary primary succession. As the on-shore winds are deflected upwards by this dense margin, sand is deposited at its windward side. If *Scaevola thunbergii* is still present on the windward side, the additional sand is seldom very much and is fixed by these low woody plants together with the marginal climbers already described for Closed Dune Scrub. *Carpobrotus dimidiatus* frequently grows into this low, very dense canopy from the seaward margin and may occur as high as 2,1 m above ground, whereas, under undisturbed conditions, this occurs directly on the surface of the sand in open situations. Landward of this margin, the dense wind-trained canopy of the primary communities rises steadily, independent of the topographical profile, as has been described already.

Where incutting by wave action has been sufficiently far landward to remove the *Scaevola*-clad dunes, the resultant seaward faces are generally too steep and have insufficient insolation for *Scaevola thunbergii* to re-colonize (see Fig. 31). These mesoclinal banks remain steep, since they are protected by roots or collapsed stems of the former vegetation. Much of this vegetation is killed, but several species are able to tolerate the change in the

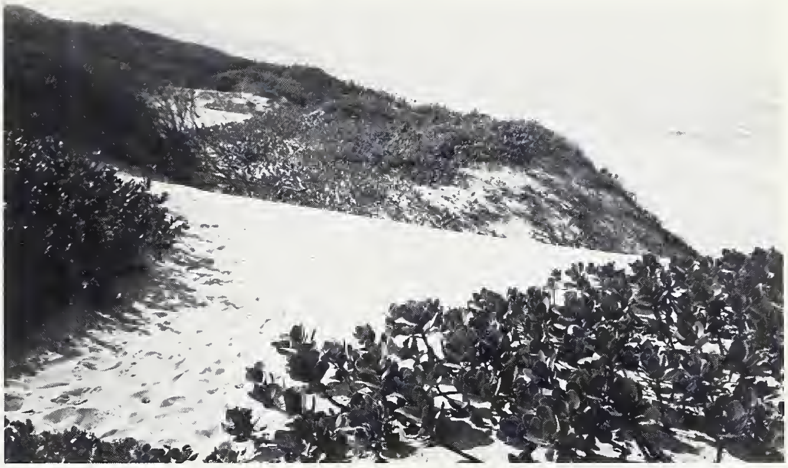


FIG. 31 - Migrating dunes partly stabilized by *Scaevola thunbergii* (right and centre) and coppice shoots of relic *Mimusops caffra* (left). Other *M. caffra*, more in direct path of southerly winds, with dead twigs (left mid-ground). Steep bank of seaward dune due to earlier marine action exposing bank too shaded for *S. thunbergii* recolonization. Dune Scrub above killed by effects of excess on-shore winds where exposed

environment, at least if some protection is afforded by secondary pioneers or the more salt-spray-tolerant members. Their growth-forms, however, are changed to a low form, maintained by the direct and indirect effect of wind. Due to the change in the topography, the effects of wind and salt-spray are changed: these are very severe on the exposed parts (especially on the south to south-west slopes), but, with the wind being forced upwards more steeply, their effects are reduced on the leeward of the scrub. This results in a steeper canopy profile being formed than under primary conditions.

Of considerable importance on these steep banks, and particularly in fixing sand blown against the base, is *Gazania rigens* var. *uniflora*. Another pioneer, but less frequent, is *Launaea sarmentosa*. *Carpobrotus dimidiatus* is very common, but this generally follows the above two or occurs in better soils. *Ipomoea pes-caprae* frequently follows colonization by *Gazania rigens* var. *uniflora* at the base of the steep banks, if subsequent wave-action does not prevent this.

The most common woody plant in the lower or exposed parts of this modified scrub is *Carissa macrocarpa* which is almost prostrate at first. Together with this, and sometimes also very short, are *Maytenus procumbens* and *Eugenia capensis*. *Maerua nervosa* occurs wherever the cover is short enough, but not on the very steep southern aspects, unless protected. *Chrysanthemoides monilifera* subsp. *rotundata* occurs mixed with these, if sufficiently open, but precedes the woody plants on the north-eastern sides where some protection is afforded from the very strong southerly winds. *Ficus burtt-davyi* is a very common rambling shrub in this stunted scrub but is frequently leafless on those parts exposed to the stronger winds. *Mimusops caffra* also extends into the lower reaches of this scrub, as a very short shrub, but is generally on the leeward of *Carissa macrocarpa* or the other more tolerant plants. Very common in this stunted scrub are such climbers and scramblers as *Rubia cordifolia, Cynanchum obtusifolium, Rhus nebulosa, Rhoicissus digitata, Gloriosa superba* and, where not shaded, *Commelina erecta*.

Above these *Maytenus nemorosa* and, where better protected and with more insolation, *Brachylaena discolor* occur. This in turn passes into tall scrub or *Mimusops caffra* Woodland as described in Section 4.2.1.1.

Man aggravates the disturbances mentioned above and through trampling, felling or firewood-gathering causes further changes, both directly and indirectly (through subsequent wind action).

Trampling reduces the angle of the slope, loosens soil and directly destroys the cover. These effects add up to bare surfaces of drier loose sand, more readily driven by wind up a slope less steep than if man had not been present. This results in increased quantities of sand being blown inland from the strand or from the disturbed dunes. The latter results in blow-outs and further damage through excavation, while burial, abrasion and increased salt-spray destroy established vegetation further inland (see Figs 10-13).

In loose sand exposed to strong on-shore winds primary strand pioneers may become established. Where the wind and salt-spray effects are reduced, *Cyperus natalensis* (leafy form) becomes an important colonizer. Where partial stabilization occurs, and this is generally where the organic content or the soil-water relations have been improved, *Gazania rigens* var. *uniflora* and *Sporobolus virginicus* are important pioneers. Less frequent are *Launaea sarmentosa, Stenotaphrum secundatum* and *Paspalum vaginatum* (only in shallow soil on an old beach road or rocks). In stabilized open situations with improved soils, *Panicum chusqueoides* occurs as a pioneer, generally extending out from the margin of more mature vegetation.

If stabilization is satisfactory, plant succession along lines similar to those discussed under primary succession is effected; namely, herbaceous pioneers to open scrub dominated by *Chrysanthemoides monilifera* subsp. *rotundata* or *Passerina rigida* to *Eugenia capensis* open scrub to closed scrub or woodland, with continuous improvement to the soil. Differences, however, occur in the composition of the earlier stages of this secondary scrub where a reduction in salt-spray or in the effect of direct on-shore winds occurs. This happens with a levelling or drop in the topography or follows a rapid development of vegetation on the windward side of open disturbed places. In these cases, *Ficus burtt-davyi* becomes an important early shrub as also do *Brachylaena discolor* and *Carissa macrocarpa*. The last is, however, more important on mesoclines with lower insolation and exposed to on-shore winds. *Brachylaena discolor* is also general on soils too poor for the other two and, with time, it becomes the dominant of this secondary seral community. *B. discolor* occurs not only in the seaward communities, but also in any disturbed open situations, generally where the soils are too poor initially for direct competition with its shade-producing would-be competitors.

4.2.1.2.2 Disturbed closed communities

Where disturbance is such that there is little or no subsequent movement of soil by wind, re-colonization is effected by regeneration of plants still present, by woody scramblers and various climbers extending from the margins and by secondary invaders. The pattern of recolonization is affected mainly by the size of the disturbed area, the degree of interference, aspect and edaphic conditions.

4.2.1.2.2.1 Restricted disturbance

In places where there has been limited interference, so that the soil is not unduly disturbed and the margin is relatively large compared with the total area of the disturbance, lianas and woody scramblers are very important in subsequent succession. These generally follow and replace the more rapid initial colonization by *Panicum deustum, P. chusqueoides, Chrysanthemoides monilifera* subsp. *rotundata* and, in places, *Lantana camara* or, where shaded, by *Lycopersicum* sp. and *Zehneria parvifolia*. The presence of a relatively high frequency of these scramblers or lianas indicates local disturbance often for many years after this has taken place. The more common representatives of this group include *Grewia occidentalis, Scutia myrtina, Rhus natalensis, R. nebulosa, Dalbergia armata, Acacia kraussiana, Ficus burtt-davyi* (poorer soils) and, more inland, *Grewia caffra*. These are followed by trees and shrubs of *Mimusops caffra* Woodland or early forest, of which the following are more common initially: *Brachylaena discolor* (generally in disturbed soils, see previous section), *Clausena anisata, Allophylus natalensis, Deinbollia oblongifolia, Clerodendrum glabrum, Bersama lucens*. This returns directly to Dune Forest, frequently without *Mimusops caffra*, unless this is on poorer soils and subjected to on-shore winds, in which case *Brachylaena discolor* is likely to have been the dominant precursor.

4.2.1.2.2.2 Widespread disturbance

(A) MISCELLANEOUS CLEARING - In more open situations where there is no direct effect of on-shore winds and where the soil has a good organic content, herbs are important secondary pioneers. These include annuals and perennials which, at least during the rainy season, develop rapidly in disturbed places.

Ephemeral species include *Solanum nigrum, Australina acuminata, Bidens pilosa, Cenchrus brownii* (poor soil), *Commelina benghalensis, Crassocephalum crepidioides, Datura stramonium, Euphorbia hirta, E. hypericifolia, Lactuca indica, Oenothera indecora* (poor soils), *Physalis angulata, P. peruviana, Rhynchelytrum repens, Senecio madagascariensis* and *Xanthium strumarium*.

Occurring with these, but of longer duration, are *Panicum chusqueoides, P. deustum, P. maximum, Cyperus natalensis* (leafy form), *Abutilon sonneratianum, Ambrosia artemisiifolia, Boerhavia diffusa* var. *diffusa* (poor soils), *Carpobrotus dimidiatus, Dactyloctenium australe, Dalechampia capensis, Desmodium canum, Droguetia urticaefolia, Eupatorium odoratum, Laportea peduncularis, Mariscus dubius, M. macrocarpus* and *Senecio chrysocoma*.

Included among these secondary pioneers is a suffrutex, *Solanum aculeatissimum*, and such shrubs as *Chrysanthemoides monilifera* subsp. *rotundata, Lantana camara, Ricinus communis* and *Solanum mauritianum*. The earliest tree, apart from regenerating relicts, is *Trema orientalis* which is not tolerant of very dry conditions or salt-spray and occurs only very occasionally with these pioneers on the white sand dunes.

Of the above-mentioned, *Lantana camara* and, to a lesser degree, *Chrysanthemoides monilifera* subsp. *rotundata* become the most widespread. These form a dense spreading scrub which shades out the majority of the above-mentioned species (except the taller members), but in turn is invaded by shade-tolerant woodland or forest-precursor species. *L. camara* is a more aggressive invader of shorter or more open vegetation than *C. monilifera* subsp. *rotundata*, particularly under the influence of fire. It is, however, less tolerant of salt-spray, thus it occurs on the leeward of taller vegetation or where protected by unevenness of the topography. Both *L. camara* and *C. monilifera* subsp. *rotundata* bear fleshy fruits which are eaten by many birds and mammals. These visitors in turn drop seeds of other fruit-bearing plants and it is the shade-tolerant members of these that develop beneath the scrub and allow the succession to return to closed wooded communities leading eventually to forest.

(B) SUCCESSION ON DISUSED GOLF COURSE (GRASSLAND SUCCESSION) - As was pointed out when dealing with Dune Forest, primary succession is from open strand communities to closed forest. Grasses are relatively poorly represented and are only subordinate. However, a considerable portion of these dunes was covered by grasses until this section was destroyed in the latter half of 1969. At the time of destruction the former open grassland was closing to scrub in many parts (see Figs 24, 30 and 46).

The open grassed areas on the well-drained white sands merged with low-lying grassland or grassland-woodland mosaic communities. The latter two are regarded as being late stages in riparian succession and are not dealt with here. The first-mentioned was created by the direct and deliberate action of man.

Although the soils fundamentally were well-drained white sands, the grasses had become established on a well-developed organic layer, a relic of forest conditions. Nevertheless, due to trampling, drainage or localized wind-sorting, there were variations in the organic content and in some parts the substrate was poorer and of looser sand.

A considerable amount of former forest was cleared to create a nine-hole golf course which was opened in 1916. Only a few isolated specimens of *Mimusops caffra* were left (data from miscellaneous early photographs). The fairways or greens were planted with runner grasses (fide H.S. Ratcliff, 1952), chiefly *Cynodon dactylon* (Forbes, 1922), although, from relics in 1949, there seems to have been a considerable admixture of this species with *Dactyloctenium australe, Sporobolus virginicus* and *Stenotaphrum secundatum*, particularly on the fairways. There is little doubt that others such as *Digitaria longiflora* and *Sacciolepis curvata* developed in the open parts, whilst tufted grasses probably developed in the roughs at the edge of the fairways. Low scrub also developed in the roughs as well as, and in particular, on ridges between the fairways.

With the outbreak of World War II, in 1939, this ceased to be used as a golf course. By 1946 a house had been built at the southern end of a ridge overlooking the Mlazi estuary (see Fig. 24) and cattle ranged on the grassland which was subjected to periodic burning.

In 1949, the greater part of the grassland consisted of short grasses invaded by tufted species, particularly on gentle xeroclines or where not in the direct path of the on-shore winds. An abrupt margin to the forest still occurred, but there was an invasion of small trees and shrubs into the grassed areas in various parts. This was particularly the case where the effect of fires was reduced. Such situations were either on the lower mesoclines, where the grasses did not support severe fires and where insolation was reduced, or in disturbed sandy places where paths or cattle tracks reduced even further the sparse cover of fire-supporting grasses.

Between 1956 and 1959 the house mentioned above was vacated and, after 1959, cattle ceased to be kept in this locality.

Fires continued to be set into the vegetation until the final destruction, but these occurred only at irregular intervals and were mostly small.

From the point of view of species lists of the total area there was little change from 1949 until 1969, but there was a very considerable change in relative frequency of the different plants. There was a marked increase in area occupied by the larger bunch grasses and scrub, and a steady encroachment by the closed woody communities from the forest margin into former grassed areas. This encroachment produced a more gradual canopy profile which is more in keeping with conditions favouring forest development than the previous abrupt margin.

Short decumbent, stoloniferous or rhizomatous grasses included *Dactyloctenium australe, Cynodon dactylon, Digitaria longiflora, Sacciolepis curvata, Stenotaphrum secundatum* and *Sporobolus virginicus*. As mentioned, these were formerly much more widespread and, by 1969, were limited to slopes subjected to on-shore winds or to steep xeroclines (where the basal cover was very low). Occurring with these in places were *Imperata cylindrica* (as an early invader of these grasses), *Eragrostis ciliaris, Perotis patens* and, in freshly disturbed places, *Rhynchelytrum repens*.

Associated with these grasses in open situations were a number of sedges, forbs and two Pteridophyta. These included the following:

Abilgaardia ovata
Aeschynomene micrantha
Anomatheca laxa (mesoclinal)
Asystasia gangetica
Bulbostylis contexta
Carpobrotus dimidiatus
Cassia plumosa var. *plumosa*
Centella coriacea
Chaetacanthus setiger
Commelina erecta
Conyza canadensis (disturbed)
Cucumis anguria var. *longipes*
Cyperus albostriatus (mesoclinal)
C. natalensis (leafy form, disturbed)
Dipcadi viride
Drimiopsis maculata
Equisetum ramosissimum (lower-lying, disturbed, no direct on-shore winds)
Gerbera piloselloides
Helichrysum kraussii (open disturbed loose sand)
Heliophila subulata
Hewittia sublobata
Hypoxis rooperi
Kyllinga alata
Mariscus dubius
M. vestitus
Nemesia denticulata
Oenothera affinis (disturbed)
Ophioglossum polyphyllum
Othonna carnosa var. *discoidea* (open, loose sand)
Oxalis corniculata
Phaulopsis imbricata
Piloselloides hirsuta
Polygala hottentotta
Silene burchelli
Sonchus dregeanus
Tephrosia purpurea subsp. *canescens* (rare, open sand, exposed to on-shore winds)
Tridax procumbens (not recorded in grassland after 1952)
Vigna unguiculata

Carpobrotus dimidiatus frequently formed extensive, flat clumps some of which were up to 4,6 m in diameter. In the event of fires in short grassland only the peripheral parts were burnt, the central part (and consequently any potential invader) escaped the effect of fire.

These in turn were invaded by tufted grasses and additional forbs. The tufted grasses included:

Aristida junciformis subsp. *junciformis*
Chloris gayana
Cymbopogon excavatus
Digitaria macroglossa
Ehrharta calycina
Eragrostis capensis
E. curvula
Heteropogon contortus
Hyparrhenia hirta
Panicum maximum
Setaria sphacelata
Sporobolus africanus
S. fimbriatus

Of these grasses, *Chloris gayana, Ehrharta calycina, Eragrostis capensis, Heteropogon contortus* and *Hyparrhenia hirta* occurred only on the more inland dunes. *E. calycina* and *H. hirta* occurred in the more open vegetation on poorer and somewhat drier soils. The remainder were more widespread, but, as mentioned earlier, did not occur in the direct path of on-shore winds. *Panicum maximum* occurred on better soils in more mesic situations and was particularly common following periodic fire encroachment into forest marginal communities. Initially *Hyparrhenia hirta* (in poorer soils) and *Cymbopogon excavatus - Digitaria macroglossa* (in better soils) were the dominants over a great proportion of the grassland. With time and apparent improvement to the soil, *C. excavatus* assumed sole dominance in much of this area. Fig. 30 shows clearly the extent of *Cymbopogon excavatus* grassland in the southern part of the old golf course, immediately prior to its destruction.

A leafless form of *Cyperus natalensis* was a common associate of the tall grasses.

Associated with these taller grasses or directly invading the shorter grassed areas were a number of other plants.

The forbs included *Acalypha petiolaris* (-) *Bulbine asphodeloides* (-), *Cynanchum obtusifolium, Desmodium canum, Eulophia speciosa, Felicia erigeroides, Helichrysum decorum, H. longifolium* rare (-), *Priva cordifolia* var. *abyssinica, Pyrenacantha scandens, Rhynchosia caribaea* var. *picta, Senecio chrysocoma, S. madagascariensis, Thesium asterias* a hemi-parasite (-) and *Triumfetta rhomboidea*. Those with (-) occurred only where they were not affected by on-shore winds. The remainder occurred mainly out of the direct path of these winds, but may have been affected by wind eddies or occasional excessively strong on-shore winds. *Felicia erigeroides* occurred locally dominant in *Dactyloctenium australe* open short grassland, partly exposed to on-shore winds, but not mesoclinal.

Anthospermum littoreum, a spreading suffrutex, invaded short grasses on slopes affected by on-shore winds, but this, being non-tolerant of fire, was very localized.

Shrubs and small trees were represented by a number of species differing in their tolerances to various environmental factors, an important one of which was fire.

Initially these shrubs were all members of the primary dune communities and, depending upon the degradation of the micro-environment they varied from the heliophilous non-fire-tolerant *Passerina rigida* in open sandy places to woodland or forest precursor species in mesic situations. Occurring with native species on better soils, in full sunlight, or where only very lightly shaded, and out of the direct path of on-shore winds, was the naturalized alien *Lantana camara*. Over the period 1949 to 1969 this had developed from a few scattered plants to the most widespread and aggressive of the shrub invaders in those situations mentioned above. It developed a dense cover which shaded out the heliophilous species and, with time, reduced the fire factor and paved the way for forest advance. Although it will burn when subjected to fire, this is usually only the leafy peripheral parts or in the crown; thus, with an increase in size, it reduces the chance of direct contact between fire and any shade-tolerant seedlings which may germinate beneath these stands. In the event of its being subjected to severe fire it generally regenerates from the base, even though the former aerial stems are killed. Contributing to the success of *L. camara* was the uncontrolled burning practice and, on these better soils, lack of grasses capable of supporting frequent severe fires.

In the discussion which follows, where *L. camara* had been able to become established, it changed the subsequent plant succession by eliminating the heliophilous shrub stages and leading directly to shade-tolerant forest initial or precursor trees. However, where these heliophilous shrubs had already become established, or were able to invade with the aid of fire, they were still very important in the general succession.

In open situations, in the absence of fire or where this had been very much reduced, the shrub invaders lead to the development of a community of short shrubs and woody scramblers. *Scutia myrtina* and *Rhus nebulosa* were initially important examples of the latter growth-form, but in recent years such scrub, if out of direct on-shore winds, was dominated by *Lantana camara*. This, in turn, gave way to *Brachylaena discolor* scrub which later was succeeded by *Mimusops caffra* thicket in which the subordinate shrubs, field layer and climbers were essentially those mentioned under primary Dune Scrub and Woodland.

Where fire was of greater frequency, or more severe, *Carissa macrocarpa* was the most important shrub in open grassland.

Forest marginal communities varied in composition and appearance with different sets of environmental factors. In improved soils on mesoclines or in light shade, grasses occurred which supported only mild fires, or none at all. In such situations the main grass was *Dactyloctenium australe*, together with *Panicum maximum, P. chusqueoides* and *Digitaria diversinervis*. Associated with these were shade-tolerant herbs such as *Anomatheca laxa, Anthericum saundersiae, Asystasia gangetica, Berkheya maritima, Chlorophytum modestum, Cyperus albostriatus, Drimiopsis maculata, Gloriosa superba, Haemanthus magnificus, Phaulopsis imbricata, Sansevieria hyacinthoides* and *Stachys aethiopica*. These were invaded by shrubs, woody scramblers and climbers of the Closed Dune Scrub community and, out of the path of on-shore winds, by seedlings of forest-precursor trees. The woody plants in lightly shaded situations included:

Allophylus natalensis
Apodytes dimidiata subsp. *dimidiata*
Bersama lucens
Canthium obovatum
Clerodendrum glabrum
Cordia caffra
Deinbollia oblongifolia
Euclea natalensis
Fagara capensis
Hippobromus pauciflorus
Maerua nervosa
Maytenus nemorosa
Mimusops caffra
Mitriostigma axillare
Putterlickia verrucosa
Scutia myrtina
Sideroxylon inerme
Tricalysia sonderana

Herbaceous climbers included *Dalechampia capensis, Dioscorea crinita, Pyrenacantha scandens, Thunbergia dregeana, Tragia durbanensis* and *Vernonia angulifolia.*

In places receiving more sunlight, but with good soils, *Panicum maximum* generally formed a narrow margin between the fire-supporting open grassland grasses and the forest margins. The invading shrubs were, under open conditions, *Eugenia capensis, Carissa macrocarpa, Brachylaena discolor* and, occasionally in lower-lying places, *Strychnos spinosa.* Together with these, and more abundant in places where salt-spray was absent, were woody scramblers or lianas of the forest margins which were well developed and dense in such situations. These either established themselves in the marginal grassland or spread in from the forest margin itself. Such species included *Scutia myrtina, Rhus nebulosa, Dalbergia armata, D. obovata, Grewia caffra, G. occidentalis* and *Smilax kraussiana.* In later years this community, at least where its margin received direct sunlight, became dominated by *Lantana camara.* As these spread out, forest seedlings developed beneath the taller scrub. Periodic fires set back this encroachment temporarily.

In places receiving ample sunlight, but where edaphic factors were poor and fire very much reduced, *Ficus burtt-davyi*, in a scrambling to erect growth-form, was the most important forest marginal species.

4.2.1.3 COMMUNITY INTERRELATIONS

Fig. 32 shows the interrelationships of the primary plant communities on the white sands. Following the pioneer strand communities, the succession forms a continuum of closed wooded communities to Dune Forest. Throughout this series there is marked edaphic control, even in the mature forest, as discussed on page 33. This Dune Forest is considered to be the climax community and it is therefore an Edaphic Climax. Nevertheless, there is salt-spray control in parts, but this concerns mainly the shape of the upper canopy of this forest, once it has been able to develop on improved soils.

The constant presence of on-shore winds and salt-spray, influenced by the proximity of the sea and the local topography, control (together with the poor soil conditions) the initial stages of succession and provide the characteristic clipped-hedge effect of the canopy of all communities exposed to these winds. It is possible that a short complex woodland community on the seaward side of a high dune towards the north-eastern extremity of the Isipingo North white dunes represents a salt-spray climax. However, the remainder of the *Mimusops caffra* Woodland is regarded as being seral. It is hoped that detailed quantitative work on the relict vegetation left after the 1969 destruction may help to confirm this.

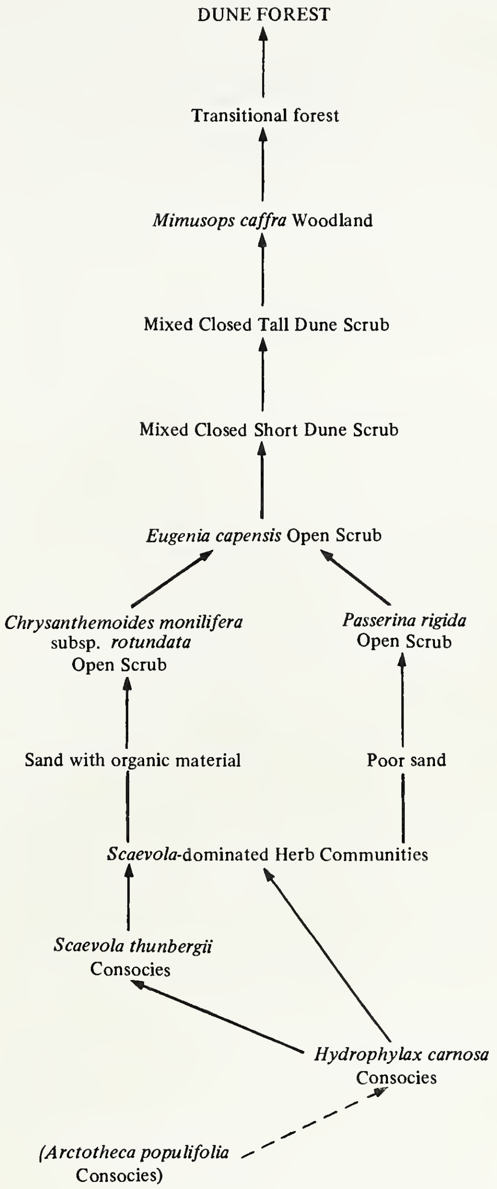

DUNE FOREST
Transitional forest
Mimusops caffra Woodland
Mixed Closed Tall Dune Scrub
Mixed Closed Short Dune Scrub
Eugenia capensis Open Scrub
Chrysanthemoides monilifera subsp. *rotundata* Open Scrub
Passerina rigida Open Scrub
Sand with organic material
Poor sand
Scaevola-dominated Herb Communities
Scaevola thunbergii Consocies
Hydrophylax carnosa Consocies
(*Arctotheca populifolia* Consocies)

FIG. 32 - Simplified interrelations of primary plant communities on modern white sands

Secondary succession following disturbance has occurred in all of the communities mentioned. In most cases disturbance is followed by retrogression with subsequent succession of a similar pattern to primary succession after the

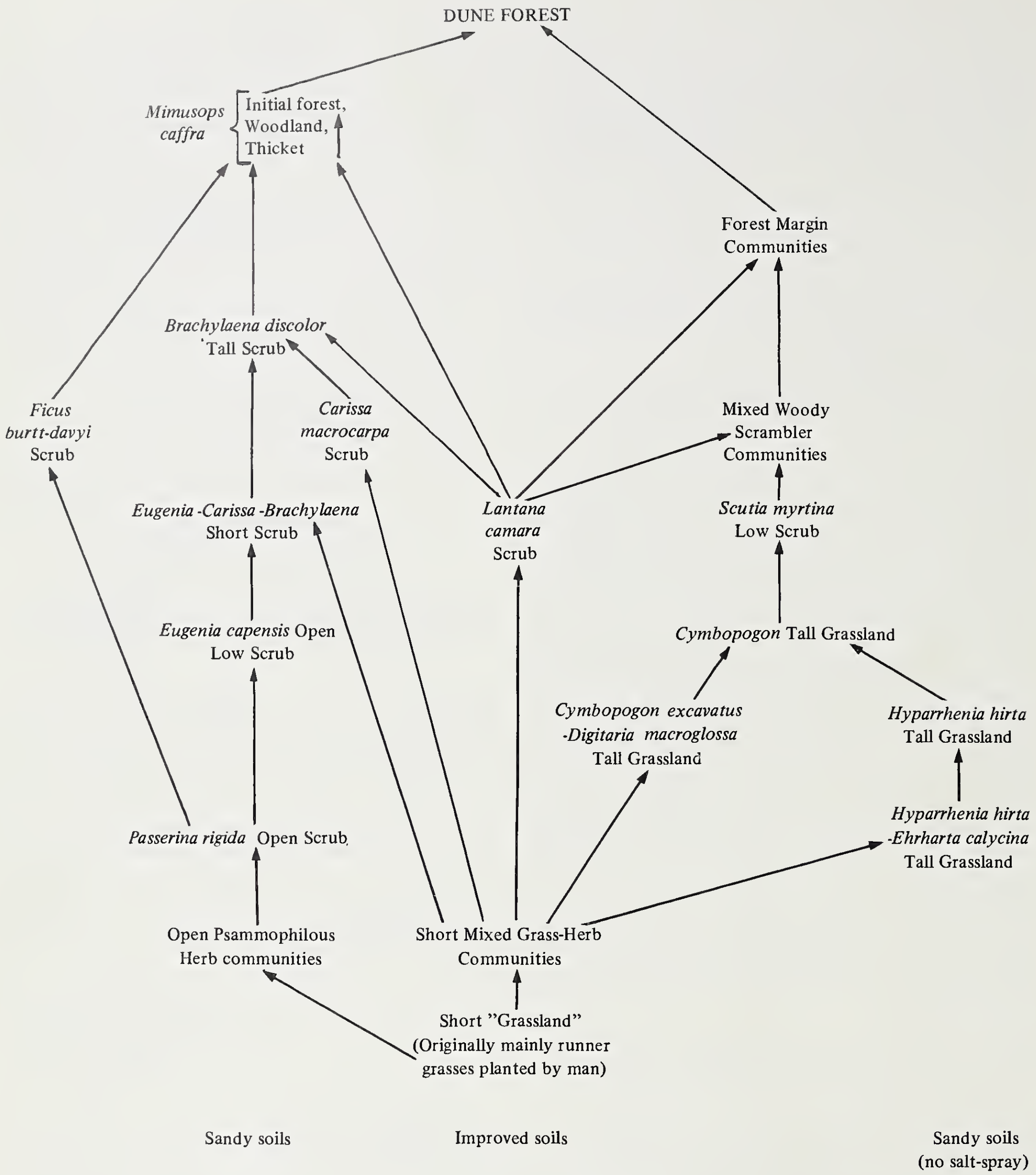

DUNE FOREST
Mimusops caffra
Initial forest, Woodland, Thicket
Forest Margin Communities
Brachylaena discolor Tall Scrub
Ficus burtt-davyi Scrub
Carissa macrocarpa Scrub
Mixed Woody Scrambler Communities
Eugenia-Carissa-Brachylaena Short Scrub
Lantana camara Scrub
Scutia myrtina Low Scrub
Eugenia capensis Open Low Scrub
Cymbopogon Tall Grassland
Cymbopogon excavatus -Digitaria macroglossa Tall Grassland
Hyparrhenia hirta Tall Grassland
Hyparrhenia hirta -Ehrharta calycina Tall Grassland
Passerina rigida Open Scrub
Open Psammophilous Herb communities
Short Mixed Grass-Herb Communities
Short "Grassland" (Originally mainly runner grasses planted by man)
Sandy soils
Improved soils
Sandy soils (no salt-spray)

FIG. 33 - Suggested interrelations of secondary plant communities on old golf course developed on destroyed forest on white sands

disturbing factor has ceased to be in control. Local occurrence of members of earlier communities in the succession amidst plants of more mature communities indicates former disturbance.

On a considerable portion of these white dunes an initially entirely different set of communities occurred. These constituted a secondary succession on a former golf course. Although this golf course was developed on dune forest soils, there were variations in edaphic and other environmental factors. In the poorer exposed soils a subsere similar to the post-*Scaevola*-stages of the prisere occurred, but, elsewhere, the communities and succession varied considerably. The major lines of succession and the interrelationships of the secondary communities on this old golf course are illustrated in Fig. 33.

4.2.2 Red sands (main hills)

These sands differ from the modern white sands in several ecologically important respects of which angle of slope, altitude and water-holding capacity are among the more important (see Section 1.4). They form the major hills in the study area: Athlone Park hill in the south, Jeffels' Hill in the south-western corner, the main Isipingo Beach hill and Donsagolo in the north-east (see Section 1.3). These hills have been undercut by sea- and river-action, with the result that many of the slopes are very steep. With time, however, rain-wash or gravitational creep have reduced the steepness of the slopes. In places where the clay content is high, disturbed banks may be vertical; also the steep form is maintained for longer periods than where the substrate is more sandy. Thus a variety of aspects with different sets of environmental factors is provided.

Insolation on the steep south-facing slopes is much reduced, particularly if vegetation is present. In winter, the steeper slopes receive no direct solar radiation (see Table 2 and Section 2.1). Throughout the year the south-western, through southern, to north-eastern slopes receive the strongest and most frequent winds, many of which blow off the sea. Therefore these slopes, with the exception of those of Jeffels' Hill, receive a considerable amount of salt-spray (see Section 2.3), at least near their bases. The upper parts of the seaward slopes receive less salt-spray than the lower parts and, depending upon local topography, this may be virtually absent. The northern and north-western aspects are not subjected to salt-spray, but are hot and dry.

Man, directly and indirectly, has had a considerable effect on the topography and vegetation throughout this section (see Chapters 3 and 5), but his influence is least on the steeper north-western and seaward slopes.

4.2.2.1 SALT-SPRAY COMMUNITIES

4.2.2.1.1 Priseres

4.2.2.1.1.1 Pioneer and early scrub communities

At the seaward base of these hills, younger beach sands have been banked against older weathered Bluff Beds, not only under conditions associated with present sea-level, but also under conditions of earlier, higher sea-levels. This has resulted in an admixture of these different sands in such places. The more stable situations have had further mixing through subsequent gravitational movement of the red sands from above. This feature is more noticeable above the main supralittoral rocks where the amount of modern sand is minimal.

In addition to the relative proportions of the different sands, there are other major variations in the physical environment on the seaward side of the main hills.

Three major variations in habitat and in early stages of succession occur. Where the supralittoral rock platforms occur at the base of the hills, maximum stability is afforded to their slopes, but these slopes are subjected to the maximum amount of salt-spray. Where the supralittoral rocks have been breached relatively recently, subsequent undercutting by the sea has resulted in very steep unstable slopes: these slopes are somewhat protected by the relict slopes above the supralittoral rocks from excessive wind, at least the south-westerlies and north-easterlies. A third variation occurs where the slopes are relatively stable, not as steep as those just mentioned and more landwards than the main supralittoral platforms: these probably represent relicts of earlier incutting by the sea at a higher level than at present. For the greater part, any supralittoral rocks which do occur in these last-mentioned situations are buried by modern sands; thus these slopes merge directly with modern beach sands towards the base.

These variations, examples of which are shown in Fig. 6, are dealt with in inverse order below.

(A) SLOPES DIRECTLY ABOVE MODERN BEACH SANDS - Where modern sands have been banked up against the lower parts of older hills, the pioneers in the lower parts are basically those which have been described already for the white sands. Compared to the strand, however, there are better soil-water relations and reduced insolation on these slopes, which conditions appear to be unsuitable for *Hydrophylax carnosa* and *Scaevola thunbergii.*

The most common pioneer of recently wind-blown sand is *Gazania rigens* var. *uniflora* or, where the environmental factors are somewhat improved, *Cyperus natalensis* (leafy form). An increase in *C. natalensis* (leafy form) generally is an indication of former disturbance and subsequent movement by wind.

Also common as a pioneer in the lower parts, but less abundant than *G. rigens* var. *uniflora*, is *Launaea sarmentosa.* Occurring less frequently with these and extending to the beach sand in parts are *Ipomoea pes-caprae* and *Canavalia maritima.* Of more rare occurrence in these pioneer communities is *Lagenaria mascarena.* These are followed by *Carpobrotus dimidiatus, Cynanchum obtusifolium* and later by several other herbs or small shrubs. These, having the advantage of being established on more mature or stable soils, frequently extend out into uncolonized sand to aid in its stabilization.

This early vegetation develops into a low scrub, 10-25 cm tall on the seaward margin, in which *Ficus burtt-davyi, Carissa macrocarpa* and *Maytenus procumbens* are the most common woody species, while *Aloe thraskii* is the tallest member. Where salt-spray is excessive, *F. burtt-davyi* is less conspicuous. Associated with these are low forms of *Chrysanthemoides monilifera* subsp. *rotundata* (frequently the first of these shrubs), *Eugenia capensis, Mimusops caffra, Maerua nervosa, Rhus nebulosa, Pavetta revoluta* and *Brachylaena discolor.* Occasionally *Hibiscus tiliaceus* occurs in a low rambling form on these seaward slopes, apparently where fresh-water seepage occurs at times.

In addition to the pioneers mentioned above, herbs include *Asystasia gangetica, Gloriosa* *superba, Commelina erecta, Sonchus oleraceus, Tetragonia tetragonoides, Panicum chusqueoides, Aptenia cordifolia, Sporobolus virginicus, Dactyloctenium australe, Mariscus macrocarpus, Gladiolus gueinzii* and in mesic, but not shaded, situations *Heteroptelis suffruticosa.* Occurring occasionally in this stunted scrub are *Barleria obtusa, Bonatea speciosa, Ehrharta erecta* var. *natalensis, Haemanthus puniceus, Solanum geniculatum* and *Vernonia angulifolia.* These, however, follow later in succession, occurring on more improved soils or where there is a reduction in salt-spray.

A very common vine, *Rhoicissus digitata*, and herbaceous climbers such as *Hewittia sublobata, Ipomoea ficifolia* and *Tragia durbanensis* contribute to this low complex vegetation which produces a dense cover to the soil. *Strelitzia nicolai* becomes important in the upper parts of these slopes where salt-spray is reduced and soil-water relations are improved (see Section 4.2.2.1.1.2).

(B) STEEP UNSTABLE SLOPES - Slumping of the seaward slopes has laid bare the surface which is able to be colonized by primary pioneers. Not all of the unstable slopes require colonization since a considerable amount of vegetation which occurs on these lower slopes slides down, with topsoil from the more mature upper parts, as shown in Fig. 6.

On the very steep south-facing or shaded slopes, superficial Cyanophyta occur, not only on exposures of calcareous sandstone as discussed in Section 4.1, but also on nearby sand, at least while moisture is available.

Angiosperms are, however, the more widely spread pioneers, occurring throughout except in the permanently shaded parts near the extreme base. *Heteroptelis suffruticosa* occurs as a pioneer on the steep south-facing slopes subjected to salt-spray and where the soils are somewhat moist. Occurring with this, and more abundantly, are *Launaea sarmentosa* and *Gazania rigens* var. *uniflora*, both of which also occur in places with higher insolation (see Fig. 34). Where environmental factors permit, other pioneers include *Carpobrotus dimidiatus, Cynanchum obtusifolium* and *Gladiolus gueinzii.*

Sporobolus virginicus also occurs as an occasional pioneer where not shaded and moisture is readily available. Where more sunlight is available and in loose sandy soil, *Tephrosia purpurea* subsp. *canescens, Canavalia maritima, Ipomoea pes-caprae* and, generally higher up the slopes, *Othonna carnosa* var. *discoidea* occur as occasional herbs. In similar situations, but in deeper sands and where protected from excessively strong on-shore winds, *Cyperus natalensis* (leafy form) is a common colonizer.

In places exposed to sunlight, this community of scattered pioneer herbs is invaded by a low spreading suffrutex, *Anthospermum littoreum* and, in deeper soils, *Passerina rigida* which, unless there is further erosion, becomes the dominant of a low

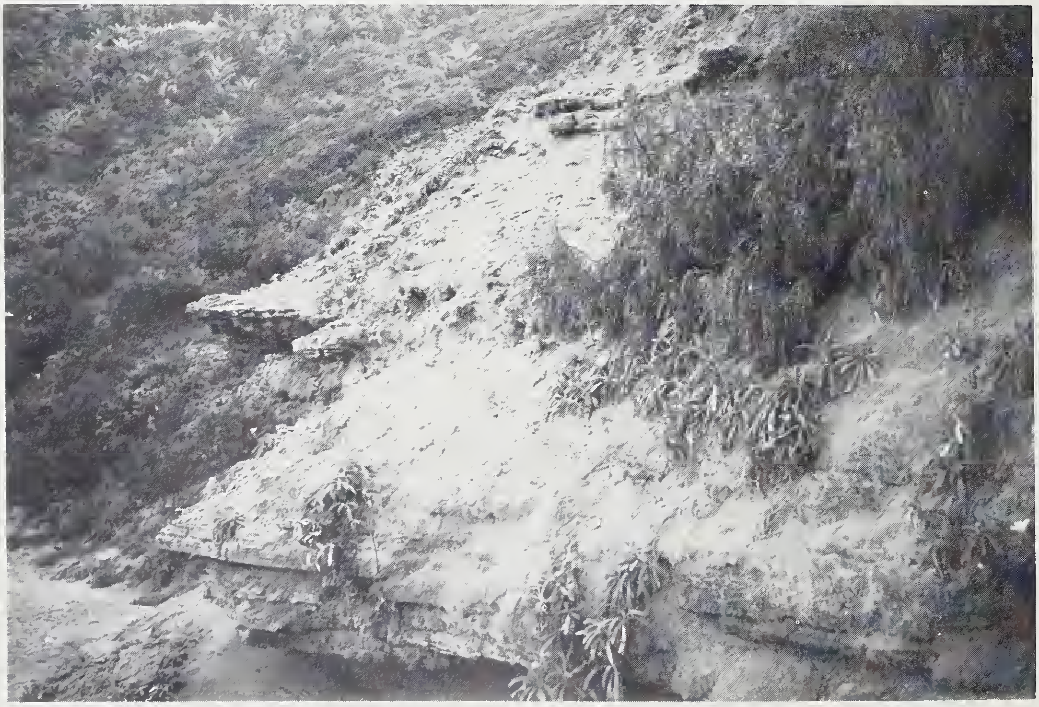


FIG. 34 - Pioneer community on steep unstable seaward slope. *Gazania rigens* var. *uniflora* most abundant forb. Also present *Launaea sarmentosa* and *Heteroptelis suffruticosa* (further back). *Paserina rigida* shrub on right. More mature closed scrub in distance also on unstable slope

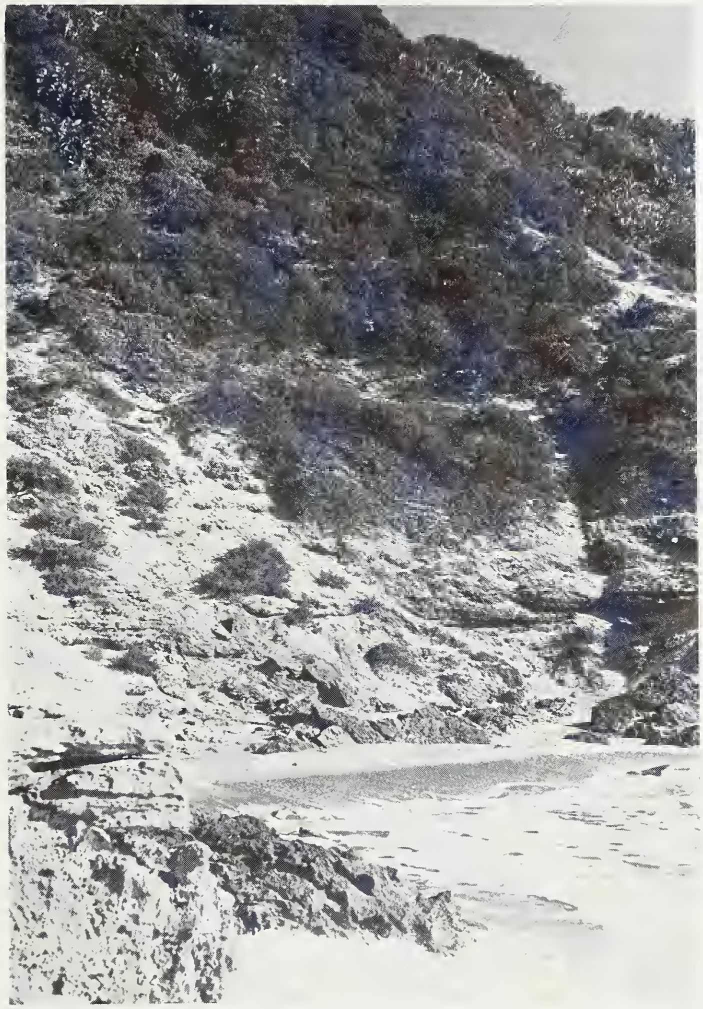


FIG. 35 - Unstable slope partly colonized by open scrub. Taller of lower shrubs is *Passerina rigida*. Low shrub on lower slope is *Maytenus procumbens*. These and *Chrysanthemoides monilifera* subsp. *rotundata* in scrub above, eventually passing to *Strelitzia - Brachylaena - Mimusops*-dominated taller scrub

open scrub. The shrubs increase in height where the effect of on-shore winds is decreased.

Occurring as subordinates in this open scrub, mostly where salt-spray has been further reduced and the soils improved or partly stabilized, are the above herbs, except *Heteroptilis suffruticosa*, together with the following: *Chrysanthemoides monilifera* subsp. *rotundata, Aloe thraskii, Asparagus densiflorus, Commelina erecta, Cynanchum ellipticum, Gloriosa superba, Helichrysum cymosum, H. decorum, H. asperum, H. teretifolium, Mariscus macrocarpus, Rhoicissus digitata, Rhynchosia caribaea* var. *caribaea* and *Vigna unguiculata.*

This open *Passerina rigida* Scrub gives way to a closed scrub in which *Maytenus procumbens* is dominant at first (see Fig. 35). *M. procumbens* frequently occurs in an almost prostrate form where exposed to strong on-shore winds, especially where soils are stony or shallow. However, where better protected, *M. procumbens* occurs up to 1,5-2 m tall and is associated in a mixed closed scrub with a number of woody plants as already recorded for Closed Scrub of the White Sand dunes (Section 4.2.1.1.3).

(C) STABLE SLOPES ABOVE SUPRALITTORAL ROCKS - Above the upper platforms of supralittoral rocks the soil is relatively stable (see Fig. 6); soil wash and creep still occur, but there is no massive or easily detectable movement of established vegetation. Towards the bases of these slopes, salt-spray is extremely plentiful and, in parts, wave-splash occurs with exceptionally high seas. The effect of salt-spray or wave-splash on the vegetation varies. It is dependent not only on the amount of salt deposited on the vegetation, but also on the presence of other factors which affect growth of plants. In this regard the occurrence of rain is particularly important, since it not only washes salt off the vegetation, but also encourages growth of the cover as a whole. The vegetation and potential plant succession is described only in general terms hereunder. At different times details vary, particularly in regard to relative importance or in the amount of cover provided by individual species. This is particularly the case where the fast-growing herbs are concerned and after periodic excessive salt-deposition or some other form of disturbance to the vegetation.

The vegetation, at least that of the lower margins, resembles the dwarf scrub and herb communities described for the supralittoral rocks (Section 4.2.1), from which it grades directly in parts. The soils, however, are deeper, there is an increased amount of fresh water seepage or storage, and there is a reduction in insolation on these slopes compared with the supralittoral rocks.

Where wave-splash occurs or salt-spray is particularly excessive, *Chenolea diffusa* is locally plentiful. Other, more widely spread pioneers which are also tolerant of salt-spray are *Sporobolus virginicus, Gazania rigens* var. *uniflora, Paspalum vaginatum* (higher water table) and *Launaea sarmentosa.*

Invading these pioneers are *Carpobrotus dimidiatus, Osteospermum fruticosum, Stenotaphrum secundatum, Aptenia cordifolia, Tetragonia tetragonoides* and less frequently *Euphorbia livida.*

Following these are several species of salt-spray-tolerant woody plants, herbs and climbers. Due to the almost constant presence of salt-spray and the high frequency of strong winds, the vegetation remains short: the woody members are extremely stunted and occur as associates of the herbs in a low complex community. *Aloe thraskii* occurs on deeper soils and becomes the tallest plant of this dwarfed community (see Fig. 17), but this, too, is killed following exposure to excessive salt-spray from exceptionally heavy seas.

Since improved soils extend to the base of these slopes, woody plants which are tolerant of salt-spray spread into the low pioneer communities. These are particularly stunted in such situations and are sometimes only 2-3 cm tall, or occur merely as a few leaves on a slender creeping or buried stem. Such extremely dwarfed species are *Maytenus procumbens, Eugenia capensis* and *Mimusops caffra*, as shown in Fig. 36. The *Mimusops caffra* shown in Fig. 36 is only a few centimetres in height whereas, on the inland side of the hill on which this photograph was taken, this species has been recorded as a tree up to 14,5 m tall with a stem 74,5 cm d.b.h.

Other woody plants of this lower section include *Carissa macrocarpa* which is sometimes locally dominant, *Maerua nervosa* and *Chrysanthemoides monilifera* subsp. *rotundata* (generally where somewhat protected from the very strong winds). Further up the slope, *Ficus burtt-davyi* occurs as a low rambling shrub together with these, as well as with:

Apodytes dimidiata
subsp. *dimidiata*
Brachylaena discolor
Canthium obovatum
Embelia ruminata
Euclea natalensis
Maytenus nemorosa
Pavetta revoluta
Rhus nebulosa
Tricalysia sonderana
Turraea obtusifolia
Strelitzia nicolai (as
an occasional seedling)

As already mentioned, herbs, suffrutices and climbers are important associates of these low shrubs. In the lower parts, in addition to those already mentioned, the following are common:

Commelina erecta
Asparagus densiflorus
Asystasia gangetica
Barleria obtusa
Crassula sp. cf.
C. natalensis
Cynanchum obtusifolium
Droguetia urticaefolia
Ehrharta erecta var. *natalensis*
Gladiolus gueinzii
Gloriosa superba
Helichrysum decorum
H. teretifolium
Ipomoea ficifolia
Kalanchoe rotundifolia
var. *genuina*
Mariscus macrocarpus
Rhoicissus digitata
Sonchus dregeanus
S. oleraceus
Vigna unguiculata

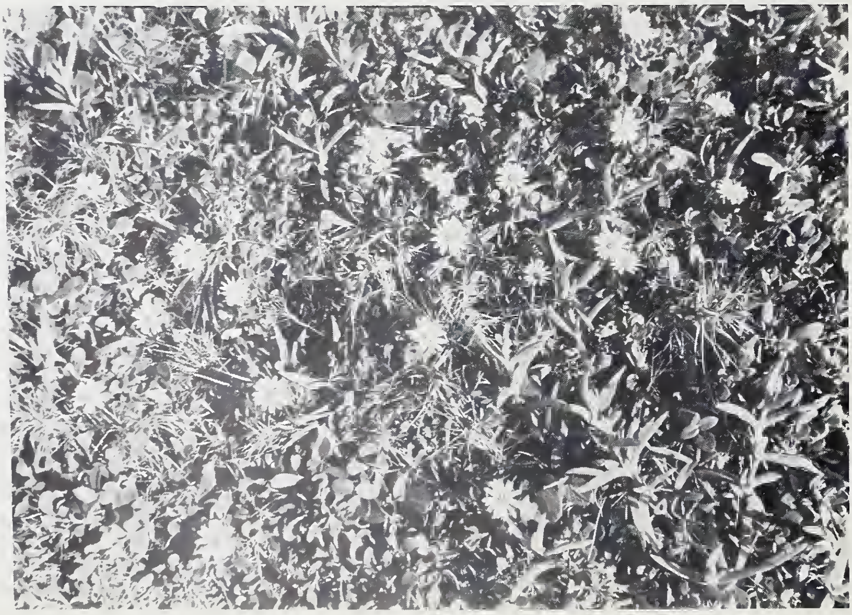


FIG. 36 - Dwarf salt-spray vegetation: mixed herb and shrub complex community. Herbs: *Osteospermum fruticosum* (flowering), *Carpobrotus dimidiatus* (succulent leaves), *Cynanchum obtusifolium* (opposite leaves in foreground), *Sporobolus virginicus* (grass), *Ipomoea* sp. probably *I. ficifolia* (cordate leaves in right background). Dwarfed shrubs: *Maytenus procumbens, Eugenia capensis* and *Mimusops caffra.* (Photo: G.M. Thomson)

Of less general occurrence, but also in the lower section, are *Bonatea speciosa, Canavalia maritima, Crassula lineolata, Panicum maximum* (in a low form) and *Phymatodes scolopendria.*

These herbaceous plants together with the dwarf shrubs form a very dense cover from which the pioneer species are generally excluded. A little further up the slopes, or in the lower part where somewhat better protected, additional herbs or suffrutices occur in this community. These include:

Anthospermum littoreum
Berkheya maritima
Cynanchum ellipticum
Cyperus natalensis
Dactyloctenium australe
Dicliptera heterostegia
Digitaria diversinervis (upper)
Drimiopsis maculata
Haemanthus albomaculatus
H. puniceus
Helichrysum cymosum (upper)
Heliophila scandens
Hypoestes verticillaris
Isoglossa ciliata
I. woodii (occasional)
Justicia protracta (south of Mbokodweni River)
Panicum chusqueoides
Pharnaceum thunbergii (upper, partially open)
Phaulopsis imbricata
Pupalia atropurpurea
Rhynchosia caribaea var. *caribaea*
Solanum geniculatum (occasional)
Tragia durbanensis
Vernonia angulifolia

This dwarfed-shrub/herb community grades directly into a closed scrub higher up the slopes.

4.2.2.1.1.2 Strelitzia-Brachylaena *Scrub*

Where there is a reduction in excessive salt-spray, as occurs with an increase in altitude or, in the lower parts, where topography provides protection, a taller closed scrub is able to develop directly from the early scrub communities described above. Aspect and edaphic factors play important roles in influencing dominance in this scrub. Initially the canopy is made up of the salt-spray-tolerant woody members of the communities mentioned above together with *Strelitzia nicolai. S. nicolai* becomes the dominant on steep south to south-east-facing relatively stable slopes. *S. nicolai* is regarded as being an indicator of improved soil-water relations and, although tolerant of on-shore winds and moderate salt-spray, it is not tolerant of excessive salt-spray or wave-splash to which some parts of the lower slopes are subjected. Furthermore, where winds are particularly severe the laminae of this species become torn, often to a considerable degree.

Where insolation is higher and soils drier, *Brachylaena discolor* becomes locally dominant (before the establishment of *S. nicolai*), particularly if there is further reduction in the amount of salt-spray. On the seaward slopes, however, *B. discolor* generally follows *S. nicolai* in establishment, taking advantage of the protection afforded by *S. nicolai* from the on-shore winds.

Where *S. nicolai* is able to become established, the canopy rises abruptly from that of the lower scrub (see Fig. 17). *S. nicolai* occurs in clumps with several erect stems which, depending upon the degree of exposure to strong winds, vary in height. The greater proportion of the aerial parts is made up of the leafy crowns, initially with little or no visible stem. With protection, the stems occur up to 2-3 m tall on the seaward slopes where *S. nicolai* is dominant (and undisturbed), or considerably taller (up to 9,5 m tall) where greater protection is afforded and where *S. nicolai* is an associate of other trees.

In more mesic places, *S. nicolai* sometimes forms pure stands. Such stands are, however, limited, since shorter woody plants generally occur scattered in this scrub which, nevertheless, is dominated by *S. nicolai.* For much of the area occupied by this scrub, where insolation is adequate, *Brachylaena discolor* occurs as a co-dominant. This species is also frequent where there has been some disturbance to the prisere, as discussed later.

In addition to those woody plants listed already for the stunted early scrub communities, *Cordia caffra, Allophylus natalensis* and *Deinbollia oblongifolia* occur in this scrub.

The field layer is poorly represented unless there has been some disturbance (as discussed later). *Panicum deustum* is, however, frequent as are also several members of the earlier communities, if sufficient light is available. In more mesic situations *Plectranthus verticillatus* occurs in this synusia while, in drier situations, *Sansevieria hyacinthoides* is frequent. South of the Mbokodweni River, a scrambling herb, *Commicarpus pentandrus*, is a common subordinate.

Climbers are well represented between clumps of *Strelitzia nicolai* or scandent on associates of *S. nicolai*, but not much on the clumps themselves. Scandent forms, in addition to those listed as members of the earlier lower scrub communities, include *Rhoicissus rhomboidea* (very common), *Dioscorea crinita, Grewia caffra, G. occidentalis* and *Thunbergia dregeana.*

With the establishment of *Strelitzia nicolai* Scrub or *Strelitzia-Brachylaena* Scrub, other woody plants to leeward are able to grow taller. With such development this scrub grades either into a mixed closed scrub on the steeper seaward slopes or into a *Mimusops caffra*-dominated forest transitional to mixed coast forest.

4.2.2.1.1.3 Closed Maritime Scrub

This occurs above the *Strelitzia nicolai*-dominant zone on steep seaward slopes subjected to strong winds. The canopy has a relatively even profile and is generally very dense, with the crowns of the constituents markedly wind-trained. This community is similar in appearance to the Closed Dune Scrub, described for the modern white sands, but there are differences in specific composition. Although *Mimusops caffra* is an important member of this community, it is not the sole dominant throughout.

The canopy is mainly 3-3,5 m tall, but varies from 2 m to 4,5 m tall, and includes the following shrubs or short trees as the more common members:

Mimusops caffra
Brachylaena discolor
Strelitzia nicolai
Maytenus nemorosa
Dovyalis longispina
Allophylus natalensis
Apodytes dimidiata
subsp. *dimidiata*
Canthium obovatum
C. inerme
Carissa macrocarpa
Cordia caffra
Euclea natalensis
Eugenia capensis
E. natalitia
Maytenus procumbens
Mimusops obovata
Ochna natalitia
Tricalysia sonderana

Of less frequent occurrence as members of the canopy are:

Acokanthera oblongifolia
Clerodendrum glabrum
Deinbollia oblongifolia
Drypetes natalensis
Grewia occidentalis
Pavetta revoluta
Sapium integerrimum
Sideroxylon inerme
Teclea gerrardii
Turraea floribunda

Smaller shrubs include *Carissa bispinosa* var. *acuminata, Chrysanthemoides monilifera* subsp. *rotundata* (open or semi-open situations), *Clausena anisata, Maerua nervosa, Mitriostigma axillare, Peddiea africana, Psychotria capensis* and *Turraea obtusifolia*.

The field layer is generally poor unless there is an opening in the canopy. The most widespread and frequent member of this layer is *Panicum deustum*. Also widespread, but less frequent, are *Asparagus densiflorus* and *Sansevieria hyacinthoides*. Other members include:

Aneilema aequinoctiale
Asystasia gangetica
Berkheya maritima
Celosia trigyna
Cyperus albostriatus
Dicliptera heterostegia
Dietes vegeta
Dracaena hookerana
Droguetia urticaefolia
Isoglossa woodii
Laportea peduncularis
Phymatodes scolopendria
Pupalia atropurpurea
(semi-scandent)

Climbers and scramblers are well represented and most extend into the upper canopy. The more common members of this synusia include:

Acacia kraussiana
Coccinia palmata
Cynanchum ellipticum
C. obtusifolium
Cyphostemma flaviflorum
C. hypoleucum
Dalbergia armata
D. obovata
Dalechampia capensis
Dioscorea crinita
D. sylvatica var.
paniculata
Embelia ruminata
Ficus burtt-davyi
Flagellaria guineensis
Gloriosa superba
Grewia caffra
Heliophila scandens
Ipomoea congesta
Lablab purpureus subsp.
purpureus var. *purpureus*
Momordica involucrata
Monanthotaxis caffra
Pyrenacantha scandens
Rhoicissus digitata
R. rhomboidea
R. tomentosa
Rhus natalensis
R. nebulosa
Rhynchosia caribaea var.
caribaea
Scutia myrtina
Secamone alpinii
Senecio brachypodus
Smilax kraussiana
Thunbergia dregeana
Tragia durbanensis
Uvaria caffra
Vernonia angulifolia

Of less general occurrence are *Diospyros villosa* var. *villosa, Capparis brassii* and *Jasminum multipartitum*.

Loranthus dregei occurs occasionally as a hemiparasite in the upper canopy, where the effect of salt-spray is reduced.

Where the effect of the very strong on-shore winds is reduced, due either to deflection by this scrub or to a change in the topographical profile or aspect, the trees are able to grow taller. *Mimusops caffra* becomes the dominant species and frequently occurs as an emergent, thus giving a more uneven appearance to the canopy.

4.2.2.1.1.4 Mimusops caffra *Transitional Forest*

With a reduction in the effect of the strong on-shore winds, the already-mentioned maritime communities on the red sands grade into forest. Initially the vegetation represents little more than a taller form of Closed Maritime Scrub, with much the same species composition as described already. In addition, there is more stratification since some of the woody members are able to grow taller than others in response to the less severe environmental conditions; furthermore, *Mimusops caffra* occurs as the dominant tree.

The later stages of this succession are not clearly shown in the greater part of the study area due to the amount of disturbance to the vegetation in most parts, other than on the steep slopes. Nevertheless, evidence suggests that *Mimusops caffra* Transitional Forest lacks the complexity, greater complement of species and mixed dominance of the inferred climatic climax forest (see Section 4.5).

On Donsagolo, where there has been the least amount of disturbance, *Mimusops caffra* Transitional Forest is well developed, although it is of only very limited extent within the study area. On the seaward slopes, its upper limit is at approximately 60 m above sea-level; above this level this community passes into a mixed forest in which *Mimusops caffra* is locally absent. On the inland side of this hill, this reduction of *M. caffra* takes place at a much lower altitude.

South of the Mbokodweni River, *Mimusops caffra* Transitional Forest is also of limited extent in the study area and is less well-developed than that on Donsagolo. Furthermore, instead of passing into forest, the disturbed, and apparently reduced, upper margin passes into woodland or scrub communities which have been able to develop with protection from fire in recent decades. Recent and current residential development has reduced even further the extent of this particular *M. caffra* community.

M. caffra occurs as a dominant in relict or re-established vegetation over a much wider area on the main Isipingo Beach hill than anywhere else in the study area. This is considered to be due to the greater degree of exposure of this hill to winds carrying salt-spray. The trend of the coastline relative to the prevailing winds, the isolated nature of the hill, its lower altitude relative to the other main hills and the rocky shore-line contribute to the increased salt-spray factor. The whole of the south-western side of the hill and the ridges on that side receive strong southerly winds which blow, from across the sea, through the gap between the Isipingo Beach hill and the Athlone Park hill. Although the north-eastern section of the Isipingo Beach hill also receives salt-spray, the on-shore winds in this section are seldom as strong as the southerly ones: this no doubt accounts for the less extensive inland occurrence of *M. caffra* on this side of the hill. Owing to the undulating nature of the terrain there is a considerable admixture of *M. caffra* with other forest trees and, on the inland slopes (apart from those of the seaward high ridge), *M. caffra* is rare or absent.

Depending upon the severity of the environmental factors, the height of the canopy and its physiognomy varies. In places which are subjected to the direct influence of on-shore winds, the dominant trees form a closed, rather even, canopy; in less exposed situations, the dominant trees occur rather as discontinuous emergents. The height of the canopy varies from approximately 5 m to 8 m, with emergents up to c. 10,5 m tall on seaward slopes. On inland slopes or where the effect of on-shore winds is reduced, more species occur as emergents and the height of these trees is generally greater, although this varies with edaphic conditions. The tallest individual measured in this community was a relict, isolated *Mimusops caffra* 14,5 m tall (stem 74,5 cm d.b.h.). This specimen was out of the direct influence of on-shore winds and in an open valley.

As mentioned, there is a direct gradation from taller Closed Maritime Scrub into this forest. While there is little change in the species composition at first, the relative importance of the individuals changes.

In addition to *M. caffra,* emergents on the seaward slopes include *Sideroxylon inerme* and *Euclea natalensis*. More frequently, however, *M. caffra* is the only emergent on these slopes and these other two occur rather as members of the upper canopy. The better represented members of the upper canopy include those already listed for Closed Maritime Scrub, where the canopy is short, or the following where the canopy is taller:

Strelitzia nicolai
Allophylus natalensis
Apodytes dimidiata
subsp. *dimidiata*
Brachylaena discolor
Canthium obovatum
Canthium inerme
Cordia caffra
Eugenia natalitia

Euphorbia ingens occurs occasionally, or locally frequently, as a conspicuous emergent in this community, but not on the south-facing slopes. It would appear that this becomes established only where there is adequate penetration of sunlight onto the surface of the soil. Therefore, while the crown sometimes appears above the canopy of the vegetation at the upper part of a seaward slope, the base of the specimen is either on the crest of the ridge or slightly over on the drier aspect.

Where salt-spray is further reduced, other species occur in the upper canopy or as emergents. Such additions include:

Ziziphus mucronata (important on xeroclines)
Chaetachme aristata (best developed where salt-spray is absent or virtually so)
Commiphora harveyi (occasional on upper seaward slopes, common on xeroclines)
Bersama lucens
Cola natalensis (generally subcanopy)
Diospyros natalensis subsp. *natalensis* (frequently subcanopy)
Erythrina lysistemon (not tolerant of much salt-spray)
Fagara capensis
Strychnos decussata (where salt-spray very much reduced)
Celtis africana (occasional, only where salt-spray much reduced)

The above-mentioned non-saltspray-tolerant members increase in relative importance further landward where eventually they and others replace *Mimusops caffra.*

Smaller trees and shrubs include those shorter members listed for Closed Maritime Scrub which are tolerant of shade, as well as the following:

Cola natalensis
Diospyros natalensis
subsp. *natalensis*
Baphia racemosa
Cussonia nicholsonii
Dovyalis rhamnoides
Drypetes natalensis
Gardenia thunbergii (rare)
Kraussia floribunda
Lagynias lasiantha
Putterlickia verrucosa
Rothmannia globosa
Vangueria chartacea
Xeromphis obovata

Another shrub, *Bauhinia tomentosa*, occurs in non-shaded situations where salt-spray is much reduced or absent. It is, however, more frequent as an associate in scrub on inland-facing slopes.

The field layer is better developed than that of the Closed Maritime Scrub and is better developed on the moister slopes than on the drier slopes. Where there has been disturbance, there is generally a good development of herbaceous plants (see Section 4.2.2.1.2). *Isoglossa woodii* is widespread and periodically is dominant in this synusia in many parts. Other members, in addition to those listed for Closed Maritime Scrub, include:

Anomatheca laxa
(light shade)
Australina acuminata
Barleria obtusa (marginal)
Chlorophytum modestum
(light shade)
Coleotrype natalensis
Crocosmia aurea
Digitaria diversinervis
(light shade)
Dracaena hookerana
(generally taller than in Closed Maritime Scrub)
Ehrharta erecta
var. *natalensis*
(light shade)
Fleurya grossa
Haemanthus albomaculatus
H. puniceus
Laportea grossa
Panicum chusqueoides
Panicum laticomum
Plectranthus verticillatus
Psilotrichum africanum

Climbers and scramblers include the following as well as those listed for Closed Maritime Scrub, except that there is a reduction in the frequency of

Cyphostemma flaviflorum and *Rhoicissus digitata* with distance from the sea. The additions are:

Adenia gummifera var. *gummifera*
Asparagus falcatus var. *falcatus*
Behnia reticulata
Capparis sp.
Cissus fragilis
Cynanchum natalitium
Dioscorea cotonifolia
Hewittia sublobata (marginal)
Hibiscus surattensis (marginal)
Rubia cordifolia
Vigna unguiculata (marginal)

In addition to *Loranthus dregei*, *L. quinquenervis* occurs as a hemiparasite, but this is generally out of the direct influence of the on-shore winds.

This community, as already mentioned, grades directly into Coast Forest, or so it is inferred from relicts in the Isipingo Beach area and from comparative studies made elsewhere, particularly in places to the north of the Isipingo Beach area.

4.2.2.1.2 Subseres

Colonization and subsequent succession in disturbed places not only are affected by ensuing environmental conditions in general, but also are dependent upon the degree of disturbance to both the vegetation and the soil. These red sandy soils, which have a varying amount of clay in their composition, when reworked by wind and water, tend to become relatively more sandy in their upper layers.

Colonization of disturbed sand with little or no clay content and the subsequent plant succession in those places where salt-spray is moderate to high is fundamentally the same as that which has been described for either the steep unstable slopes (Section 4.2.2.1.1.1.b) or the slopes above modern beach dunes (Section 4.2.2.1.1.1.a).

Where subsurface red soils have been exposed, steep to vertical banks which have a relatively high clay content often occur. South-facing banks, particularly if vegetation is still present on the upper side, receive little or no direct insolation throughout the year. Such moist-mesic situations on the seaward slopes, where there is some protection from salt-spray, are only rarely colonized by terrestrial lichens. Less infrequent colonizers are bryophytes such as *Lejeunea helenae* (Hepaticae), *Raphidorrhynchium gueinzii* and *Atrichum androgynum* (Musci). Occurring commonly and, if the above-mentioned are present, later in the succession, is a fern, *Phymatodes scolopendria*. *L. helenae* is rather subordinate to the others since it is generally epiphytic on the mosses or on rhizomes of *P. scolopendria*, as well as on exposed roots of relict vegetation. Where conditions are sufficiently damp, filamentous and non-filamentous Cyanophyta frequently occur on these more clayey exposed soils. Where salt-spray is more plentiful or insolation is high, these cryptogamic colonizers are absent as is also the case on the drier, superficially sandier soils. With the exception of *Phymatodes scolopendria*, the above-mentioned cryptogams do not appear in ordinary primary succession on the seaward slopes.

The general effect of fire in the maritime communities is discussed in Section 5.3. Fundamentally, fire reduces the cover produced by woody members and favours an increase in the number and density of forbs and grasses.

Fires in the dwarfed shrub and herb communities of the heavy salt-spray zone are rare and are mostly limited to the immediate vicinity of the site of introduction. The only fire of larger size than the small casual fires of less than 2 - 3 m^2 in area that has been observed in these dwarf salt-spray communities is one which was introduced in June 1970. Although data are inadequate, particularly in regard to long-term effects, the following generalizations are made, based on observations from this site and the very few smaller fires which have been noted within the study area.

Fires in the dwarf communities seldom kill the woody plants completely, although they cause loss of leaves and death of branches and of small plants. Recovery follows with new growth from perennial plants and with the temporary establishment of annuals of which *Sonchus oleraceus* is the most widespread. The rate of recovery varies with environmental conditions and is most rapid after suitable rains. There appears to be little change in specific composition of the community after fire, apart from the temporary increase in annuals; nevertheless, changes in relative importance values of perennials do occur, at least initially, particularly if crown cover is taken as the measure of this parameter. Certain species spread or germinate in the opened parts earlier than other members, thus they occupy a greater area than they would under undisturbed conditions. Such development varies with environmental conditions and occurs not only in parts that have been burnt, but also where there have been other forms of cover removal, provided that the soil has not been disturbed unduly. Most of these plants are rhizomatous or surface-creeping herbs. In addition a grass, *Ehrharta erecta* var. *natalensis*, which is mainly tufted but also produces roots from the lower nodes of decumbent stems, is often very prominent in the early stages of recovery of such disturbed places on mesoclines, particularly after spring rains.

In the taller shrub or tree communities on the steeper seaward slopes fire is also rare. It has, however, occurred with less infrequency and generally with more pronounced effects than in the dwarfed communities. Since there is generally a greater accumulation of combustible material, the fires are more severe. Taller members are either killed above by the direct effect of fire or new shoots, produced after a fire, are killed by on-shore winds whose deleterious effects are increased following the destruction, by fire, of the protecting plants or parts thereof on the windward side. Any relict shoots, not killed by fire, are similarly adversely affected by increased exposure to the on-shore winds. Therefore marked deformity, such as unilateral oblique growth, or death to the upper parts generally follows. While the majority of dominants are able to regenerate eventually, actual recovery is usually slow; however this depends to a large degree on the amount of protection occurring to windward.

The effect of fire is particularly severe in communities dominated by *Strelitzia nicolai*, since this species produces much combustible material and the understorey is often poor. After a fire, much bare soil is generally exposed which is liable to erosion before it is again protected by vegetation.

Plants which are able to recolonize these disturbed parts vary with different sets of micro-environmental factors. In this respect, the degree of exposure to sun, wind and salt-spray as well as the amount of disturbance to the soil, are particularly important.

One of the earlier colonizers of opened places, especially if there has been moderate disturbance to the soil, is ***Helichrysum decorum***, represented by the "form" listed as (i) in the Check-list (page 142). Another early colonizer, or invader of small herb communities, is *Panicum deustum* which is also more shade-tolerant than *H. decorum*. Other early grasses include *Ehrharta erecta* var. *natalensis*, *Digitaria diversinervis* and *Panicum chusqueoides*. The latter two which are trailing or rambling are often very prominent in early secondary succession where there is a reduction in salt-spray and insolation. Where salt-spray is much reduced, *Panicum maximum* is a common colonizer of disturbed soils. Sedges are represented in these early communities by *Mariscus macrocarpus*, or, in open situations, *Cyperus natalensis*. Early forbs, in addition to *H. decorum*, include *Celosia trigyna*, *Commelina erecta* and *Droguetia urticaefolia*. Where there is more shade provided, *Berkheya maritima* is often very common. Scandent herbs are particularly prominent in the early stages of recovery from fire or other forms of clearing. Some of these may be newly established, but, frequently, much of the cover appears to be from basal regeneration of plants established prior to the disturbance. The more common of the climbers include *Dioscorea crinita*, *Gloriosa superba*, *Ipomoea congesta*, *I. ficifolia*, *Pupalia atropurpurea* (rather a scrambler) and *Tragia durbanensis*.

These herbs develop rapidly, especially after rains. Together with, but dominating, the more-slowly regenerating woody plants, they form initial cover to the disturbed parts.

In addition to these herbs, *Chrysanthemoides monilifera* subsp. *rotundata* appears early in these disturbed communities. Not only is *C. monilifera* subsp. *rotundata* able to regenerate from aerial stems or from the base if the effect of fire is not unduly severe, but also it germinates readily in these disturbed places, particularly if the sandy soil is organically enriched. This quick-growing, soft-wooded shrub soon becomes the dominant in opened parts, where there is some protection from salt-spray. The alien, *Lantana camara*, occurs occasionally in similar situations to *C. monilifera* subsp. *rotundata*. This, however, is less tolerant of salt-spray than *C. monilifera* subsp. *rotundata* and, unlike its role in subseral scrub elsewhere in the study area, it is of minor importance on the seaward slopes.

As the slower-growing *Strelitzia nicolai*, *Carissa macrocarpa*, *Brachylaena discolor* and the other woody plants recover, so the succession returns to the prisere. Although fire in the communities on the seaward slopes in the study area is rare, the effects of fire in opening the vegetation and in favouring an increase in the number of herbs or in the relative importance of *Chrysanthemoides monilifera* subsp. *rotundata* are able to be seen clearly for several years.

In places where the inferred climax is *Mimusops caffra* Transitional Forest (see Section 4.2.2.1.1.4) there has been more disturbance to the vegetation, particularly where the slopes are not very steep. Although a considerable total area has been cleared for residential or similar development, it is considered that fire has had the greatest overall effect over the longest time of all the disturbing factors in this community. Even if the fires have not been more severe individually, they certainly have been more frequent than on the steeper seaward slopes.

In response to increased disturbance, and to environmental factors associated with less steep sea-facing slopes, herbaceous communities and open scrub or woodland are better developed here than they are on the lower and steeper seaward slopes. Comparing the subseral communities on the former slopes with those on the latter, the major differences are as follows:

(i) Grasses are better represented, numerically and specifically, both in open situations and under relict or developing wooded communities.

(ii) Although there are many species in common, there are several differences in the composition of the associated herbs and suffrutices of the early communities. Of these, the robust *Helichrysum kraussii* becomes an important invader of open short grassland or similar open early communities where insolation is sufficient.

(iii) Aliens are more frequent, although not very well represented and these are mostly where there is further protection from salt-spray.

(iv) *Chrysanthemoides monilifera* subsp. *rotundata* is better developed and is more prominent as the main precursor to woody plant invasion. This shades out *Helichrysum kraussii* and the shorter heliophytes.

(v) In response to drier conditions, *Brachylaena discolor*, often to the exclusion of *Strelitzia nicolai*, becomes the dominant in a scrub which replaces the quicker-growing *C. monilifera* subsp. *rotundata*.

All of these features are even better exhibited by the communities on red sands discussed later where salt-spray is absent or almost so. Apart from a better development of these features, the subseral communities subjected to salt-spray and those which are not show several other dissimilarities. The more prominent of these lies in the pioneer communities of soils which have been completely denuded of former vegetation and in the dominants of woodland or forest-transitional communities. One of the more common pioneers, of bare soil on upper or more distant seaward slopes, is *Stenotaphrum secundatum. Launaea sarmentosa* has also been recorded, but this is rare. In addition, *Passerina rigida* frequently invades the open pioneer herb communities. While other pioneers are common to both, none of these three species has been recorded from red sands which are not exposed to salt-spray in the study area.

The more prominent differences regarding composition of the woody communities, include the presence and later dominance of *Mimusops caffra* and the absence of *Albizia adianthifolia* in the salt-spray communities. Whereas in the communities which are not subjected to salt-spray, *M. caffra* is of only minor importance or absent, while *Albizia adianthifolia* is an important forest precursor or forest initial which becomes a dominant in later seral communities.

4.2.2.1.3 Community interrelations

The communities discussed throughout Section 4.2.2.1.1 are regarded as representing stages in a potential succession occurring on red sands subjected to salt-spray. Pioneers differ, depending largely upon edaphic factors as well as the degree of exposure to saltspray-bearing winds and insolation. Because of the almost constant presence of these winds, and depending upon their severity, succession is halted at various stages from a dwarfed shrub and herb community to *Mimusops caffra* Transitional Forest.

One of the more important individual species in this sere is *Mimusops caffra*. Although not present as a pioneer on immature soils, this species is able to become established as edaphic conditions improve. Where the effect of salt-spray is considerable *M. caffra* is extremely dwarfed and it occurs merely as an associate of other dwarfed shrubs and herbs. With a reduction in salt-spray, *M. caffra* increases in size and it becomes the dominant of the maritime communities. As long as salt-spray remains an important environmental factor, *M. caffra* maintains its dominance. Where salt-spray is reduced, other trees occur as co-dominants and, where salt-spray ceases to be an important factor, other species replace *M. caffra*. Thus potential succession leads to a climax of a forest community in which *M. caffra* does not occur (see Section 4.5).

The dwarf shrub and herb community, which occurs where the effects of salt-spray-bearing winds and wave-splash are most severe, is the only climax community of this series in which herbs occur as associates, rather than as subordinates, of the woody plants. Elsewhere a high proportion of herbs and an open canopy is indicative of earlier disturbance.

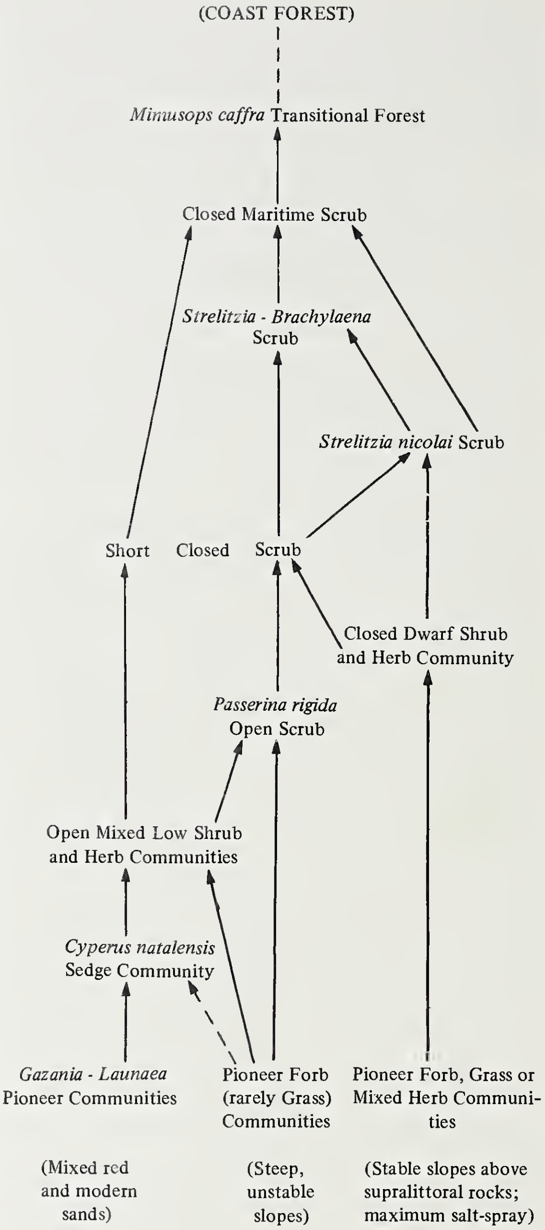


FIG. 37 - Suggested interrelationships of primary plant communities on red sands subjected to salt-spray

Fig. 37 shows the suggested interrelation of the primary salt-spray communities discussed above.

With disturbance, the plant succession is set back. The degree of retrogression depends upon the degree of disturbance and the amount of subsequent exposure to various environmental factors, particularly to salt-spray. The general succession which follows disturbance appears to be essentially the same as the prisere, but with better development of the herb communities, particularly in regard to grasses. Other plants whose relative importance increases in secondary succession, given in progressive order are: *Cyperus natalensis, Helichrysum kraussii* (where salt-spray is much reduced and insolation sufficient), *Chrysanthemoides monilifera* subsp. *rotundata* and *Brachylaena discolor* (better developed where salt-spray is reduced and insolation relatively high).

4.2.2.2 NON-SALT-SPRAY COMMUNITIES

The plant communities which occur on red sands, where salt-spray is not a limiting factor, have been far more severely disturbed, on the whole, than those communities on the seaward slopes, described above (Section 4.2.2.1).

In spite of man's continued interference with the vegetation and soils, succession towards forest is actively taking place in all parts where not deliberately disturbed by man (see Fig. 2, particularly for the changes shown on Athlone Park hill and on the inland side of the southern spur of Donsagolo). This progression is attributed primarily to a reduction in the effect of fires over the past few decades (see also Section 5.3). In other, more limited, places this has been due to the re-establishement of feral vegetation on cleared land or the re-colonization of slip-faces of steep hills, also in the absence of fires.

Variations in aspect and the steepness of the topographical profile are of paramount importance in influencing plant establishment and succession. Steepness of uncolonized slopes is governed to a large degree by the amount of clay in the soil. Thus, very steep, or near-vertical, south-facing slopes are not only cool and relatively moist, but also have a relatively high clay content. This is the general situation on Jeffels' Hill where very steep slopes have resulted from earlier undercutting by water and, to a lesser degree, by man. All other slopes, receiving more insolation, particularly those facing north to north-west, are superficially drier and the surface layers are sandy.

4.2.2.2.1 Plant communities on moist slopes

The best examples of relatively moist slopes in the study area that receive extremely little or no salt-spray are the steep south-facing slopes of Jeffels' Hill, mentioned in the introduction above (see also Figs 2 and 6).

Salt-spray is also much reduced in parts on some of the seaward slopes where protection is afforded by natural topography or by the establishment of suitable vegetation to windward. Such places, however, are of minor extent in the study area and, generally being less steep, as with other mesoclines on Jeffels' Hill, they receive more insolation. The vegetation is correspondingly drier and is discussed under Section 4.2.2.2.2.

The communities on steep south-facing slopes contain more hygrophilous components than those of the remainder of the red sands where salt-spray is not an important factor, hence their separate treatment. There is a greater affinity, particularly in the early stages of succession, with the communities of the moister parts of the alluvial flats than with those on the remainder of the red sands; nevertheless, there are several species which, in the study area, are found only on red sands. In addition, six species of vascular plant were found only on the southern slopes of Jeffels' Hill and nowhere else in the study area. Of these, two were ferns, *Pityrogramma calomelanos* var. *aureoflava* and *Pteris catoptera,* two were lianes, *Entada pursaetha* and *Quisqualis parviflora,* and two were immature shrubs, *Maytenus peduncularis* and *Xylotheca kraussiana.*

4.2.2.2.1.1 Pioneer and herb communities

Several non-vascular plants are well represented on the bare clayey sand of exposed banks. A few Cyanophyta occur on these exposed soils, but more widespread are foliose lichens which are better developed as terrestrial pioneers here than anywhere else in the study area. Bryophyta are well represented as pioneers or as invaders of the lichen or algal communities; these include *Anthoceros natalensis, Lophocolea difformis* (Jungermanniales) and a few unidentified Musci. Although these plants contribute towards the stabilization of the substrate, establishment of vascular plants is not dependent upon the prior colonization of these smaller pioneers.

An occasional vascular plant pioneer on these steep clayey banks is *Pityrogramma calomelanos* var. *aureoflava.* More common pioneers are hygrophilous herbs or, because of the amount of disturbance by man, several annual ruderals. These lead to the development of a herb community dominated by grasses.

In wetter places, grasses include *Leersia hexandra, Paspalum scrobiculatum* and *Ischaemum arcuatum*; of these, *I. arcuatum* frequently becomes an early dominant in such places. Where soils are sandier, although still on the mesocline, other grasses occur; these include a robust form of *Cynodon dactylon, Panicum maximum* and *Ehrharta erecta* var. *natalensis; P. maximum* becomes the dominant of these. Occurring throughout with these grasses, but nowhere dominant, is *Sacciolepis curvata,* while of less frequent occurrence is *Digitaria longiflora.* In shaded places, although more generally later in succession, *Digitaria diversinervis* and *Dactyloctenium australe* occur with the early grasses.

Associated sedges and forbs include:

Cyperus denudatus
  var. *sphaerospermus*
Aristea ecklonii
Asystasia gangetica
Australina acuminata
  (mostly shaded)
Centella coriacea
Commelina benghalensis
C. diffusa
Eulophia speciosa
Gnaphalium oligandrum
  (particularly where disturbed)
Helichrysum decorum
  (occasional)
Kyllinga elatior
Mariscus dubius
M. sieberanus
Pellaea viridis
Oxalis corniculata
Pycreus ferrugineus
Senecio madagascariensis
  (occasional)

Occurring commonly with these is a twiner, *Hewittia sublobata.* This low herbaceous community is invaded by taller herbs, suffrutices and, developing more slowly or coming in later, woody plants. Early herbaceous invaders include:

Aneilema aequinoctiale
Barleria obtusifolia
Cyperus distans
Desmodium hirtum
Eriosema parviflorum var. *parviflorum*
Helichrysum cymosum
H. panduratum
Laportea peduncularis
Hibiscus surattensis
Lagenaria mascarena
Mariscus riparius
Nidorella auriculata
Senecio chrysocoma
Setaria chevalieri
Sutera kraussiana
Tephrosia polystachya (occasional)
Thelypteria dentata (damp shade)
Triumfetta pilosa var. *effusa*
T. rhomboidea
Vernonia angulifolia

The taller plants or the aggressively spreading ones, such as *Laportea peduncularis* (in shaded, generally damp places), *Helichrysum panduratum* or *H. cymosum,* shade out the lower-growing herbs. With an increase in shade, *Ehrharta erecta* var. *natalensis* becomes relatively more important; there is also a better development of *Digitaria diversinervis* and *Dactyloctenium australe.* In addition, a small geophyte, *Anomatheca laxa* becomes established in lightly shaded parts as also does *Cyperus albostriatus*, although this is more common later in succession.

4.2.2.2.1.2. Scrub communities

The taller suffrutices and woody plants which invade pioneer or early herb communities include the following:

Albizia adianthifolia
Berkheya bipinnatifida subsp. *bipinnatifida*
Brachylaena discolor
Bridelia micrantha
Cestrum laevigatum
Chrysanthemoides monilifera subsp. *rotundata*
Eupatorium odoratum
Lantana camara
Melia azedarach
Psidium guajava
Solanum mauritianum
Trema orientalis

In addition, climbers are common in the early scrub. Of these, *Ipomoea congesta* is best represented on the lower slopes, while others include *Hewittia sublobata* and *Vernonia angulifolia*, as already mentioned, as well as *Mikania cordata.*

Of the remainder, *B. pinnatifida* subsp. *bipinnatifida* and *L. camara*, are among the quicker-growing and frequently dominate the early stages of scrub development. The former occurs in relatively damper places than the latter. These two form a dense cover which shades out the heliophilous herbs and, particularly where *L. camara* is concerned, slower-growing heliophilous shrubs as well. Adding to the shade effect are the climbers mentioned above. Occurring with these early invaders, but less commonly, are *Eupatorium odoratum* and *Chrysanthemoides monilifera* subsp. *rotundata. E. odoratum* which occurs in drier, sunnier places is of only minor importance as a scrub precursor on these slopes.

The quick-growing alien trees, *Solanum mauritianum, Cestrum laevigatum* and *Melia azedarach*, as well as the somewhat-slower-growing *Psidium guajava* are generally indicative of former disturbance and, in time, are shaded out by taller-growing plants. Of these, the best represented is *C. laevigatum* which appears to be the most shade-tolerant, particularly in seedling or juvenile stages. Occurring up to approximately 4 m in height, *C. laevigatum* frequently becomes a dominant in early tall scrub replacing *B. bipinnatifida* subsp. *bipinnatifida* or *L. camara* in lower, damper parts.

Trema orientalis which generally occurs in disturbed woodland or forest occurs occasionally as an invader of open herb communities on improved soils.

The remaining three mentioned in the list above are, or at least become, the more important members of the woody seral communities. *Bridelia micrantha* is the most hygrophilous of the three and does not occur in salt-spray communities or on drier slopes of the red sand hills in the study area. This invades open herb communities or lightly shaded situations early in scrub development on these moist slopes. The other two species are more widespread. *Brachylaena discolor* is most important in the succession on these slopes and is often dominant from the earliest stages of shrub invasion, becoming established before the rapidly growing herbaceous or soft-wooded precursors produce too much shade. *Albizia adianthifolia* also becomes established in herb or open scrub communities. It is not, however, as prominent in the early stages of wooded community development as *B. discolor.* This is probably due to its rather slender, spindly growth form at first, particularly where there is competition. As it increases in height and receives sufficient sunlight so its crown spreads, thereby shading other members of the community.

Initially the above plants form a low open scrub with members scattered in the formerly grass-dominated or mixed herb communities. With further invasion, or spread of those already established, a closed scrub is developed. The shorter members are eventually ousted by the taller plants and, with an increase in size of the dominants, the scrub or spreading thickets lead to the development of woodland communities.

Subordinates in the early closed scrub, apart from the climbers mentioned above, are poorly represented, especially where *L. camara* forms dense low tangles. However, with an increase in canopy height, as is better exhibited where trees or the more robust shrubs are able to become established, many seedlings of forest trees and shrubs are able to germinate. The majority of these are animal distributed and are particularly abundant under those plants which bear fleshy fruits.

The field layer, apart from the seedlings of invading plants, is dominated by creeping grasses such as *Dactyloctenium australe* (light shade), *Digitaria diversinervis* and *Panicum chusqueoides.* Other common herbs include *Achyranthes aspera,* *Australina acuminata, Cyperus albostriatus, Dicliptera heterostegia, Thelypteris dentata* (damp places) and, more sparsely distributed, *Haemanthus magnificus* and *Rivina humilis* (lower slopes).

4.2.2.2.1.3 Woodland and early forest communities

With an increase in height of the trees and with changes in the field layer, as mentioned above, scrub grades into woodland.

Brachylaena discolor, already mentioned as a dominant in scrub, maintains its dominance into early forest. In the absence of salt-spray and under mesic conditions, *B. discolor* is able to grow taller here than in any of the hitherto-described communities in the study area. Specimens were measured up to 11,7 m tall and individual stems up to 48 cm d.b.h.

A co-dominant of *B. discolor* in woodland communities, although rather achieving this status later in succession and eventually dominating *B. discolor*, is *Albizia adianthifolia*.

In the relatively moister, generally lower, parts *Bridelia micrantha* occurs initially as a co-dominant, also persisting into forest.

The other tree species, mentioned in the last section, do not grow to the same height as the above three trees, consequently they are generally shaded out earlier in the succession than these.

Several other trees occur in the woodland communities. Some appear in late scrub or early woodland stages in relatively open parts, others become established only in the shade of the precursors. The more common additional trees occurring early in this succession inlude *Antidesma venosum, Canthium inerme, Clerodendrum glabrum, Millettia grandis* and, in the lower parts, *Ficus capensis* and *Syzygium cordatum*.

These additional trees together with others developing in their shade increase the complexity of the former community. With the establishment of additional subordinates there is an increase in stratification. Where fire or other forms of interference are excluded, there is a continuous increase in the complexity of all synusiae leading towards the development of Coast Forest.

The most mature community that exists today on these moist slopes is best described as Early Coast Forest. This community occurs on a slope apparently undercut by past floods of the Mbokodweni River. Although this area was not studied until recent years, early photographs show that in 1937 this slope was already clad with woody vegetation (see Fig. 2). It is now transitional between woodland and forest. Its dominants still include the main woodland species (although several others which have become established later in the succession extend into the upper canopy or are emergents). In addition, the presence of juvenile trees or other species of more mature forest communities indicates the potential succession and emphasizes the relative instability of this community.

The steepness of the slope nullifies to a degree the shading effect of tall trees over shorter plants, if the latter are situated higher up the slope. The discontinuous upper canopy or emergents, vary from approximately 6 m to 12 m in height, or even shorter on the margins or where this merges into scrub. The tallest tree measured was a *Canthium obovatum* at 12,2 m.

The most abundant of the taller trees is *Brachylaena discolor*. Other tall trees (8,5-12 m) include *Albizia adianthifolia, Bridelia micrantha, Canthium obovatum, Ekebergia capensis, Ficus capensis, F. burkei* and *Millettia grandis*. Shorter canopy trees (6-8,5 m tall) include *Apodytes dimidiata* subsp. *dimidiata, Clerodendrum glabrum, Croton sylvaticus, Erythrina lysistemon* (upper), *Protorhus longifolia, Rhus chirindensis* f. *legatii, Sapium integerrimum, Syzygium cordatum* and, usually indicative of disturbance, *Trema orientalis* or, more rarely, *Melia azedarach*.

Shorter trees or shrubs occurring where the canopy is not closed by the above trees include those listed for earlier stages in this succession as well as *Allophylus melanocarpus*.

The following list of sub-canopy trees and taller shrubs, 2 m and over, includes saplings of trees which are either in the upper canopy or, at least, are likely to reach this synusia, even if its height should be raised by further growth of the constituents; such species are marked with (c).

Acalypha glabrata
  (lower marginal)
Allophylus natalensis
Apodytes dimidiata
  subsp. *dimidiata* (c)
Canthium inerme
C. obovatum (c)
C. spinosum
Carissa macrocarpa
  (dry margin)
Celtis africana (c)
Chaetachme artistata (c)
Clausena anisata
Commiphora harveyi (c)
Cordia caffra (c)
Croton sylvaticus (c)
Deinbollia oblongifolia
Ekebergia capensis (c)
Erythrina lysistemon (c)
Euclea natalensis (c)
Eugenia natalitia (c)
Fagara capensis (c)
Lagynias lasiantha
  (semi-scandent)
Maytenus peduncularis
  (c-probably, but not
  represented elsewhere
  in study area)
Millettia grandis (c)
Protorhus longifolia (c)
  (several)
Psychotria capensis
Rhus chirindensis
  forma *legatii* (c)
Rhus rehmanniana
Rothmannia capensis
Strelitzia nicolai (c?,
  only one seedling
  recorded)
Syzygium cordatum (c)
Trichilia dregeana (c)
Vangueria chartacea

Smaller shrubs, less than 2 m tall (although most are capable of growing taller), include:

Carissa bispinosa
  var. *acuminata*
Mitriostigma axillare
Ochna natalitia
Pavetta alexandrae
Peddiea africana
Putterlickia verrucosa
Tricalysia sonderana
Turraea obtusifolia
Xylotheca kraussiana

In view of the relatively light shade, particularly under *Brachylaena discolor* or *Albizia adianthifolia*, grasses are well represented in the field layer. These include *Dactyloctenium australe, Digitaria diversinervis, Oplismenus hirtellus, Panicum chusqueoides, P. laticomum* and *Pseudechinolaena polystachya* which are runner grasses or, at least, are diffuse. Tufted grasses include *Panicum deustum, P. maximum* (if there has been some disturbance) and, at the lower margins, *Setaria chevalieri*. Cyperaceae are represented by *Cyperus albostriatus* (very common), *Mariscus riparius* (in damper parts) and *M. macrocarpus* (where there has been some disturbance).

Of the forbs, *Isoglossa woodii* is periodically dominant in places. Others include:

Achyranthes aspera
Asparagus virgatus
Australina acuminata
Celosia trigyna
Coleotrype natalensis
Crocosmia aurea
Dicliptera heterostegia
Drimiopsis maxima
Haemanthus magnificus
Laportea peduncularis (lower margin)
Sansevieria hyacinthoides

In addition to these angiosperms, there are three ferns: *Asplenium prionitis, Pteris catoptera* (occasional) and, in the lower parts, *Thelypteris dentata.*

The majority of the climbers reach the upper canopy; these include:

Cyphostemma hypoleucum
Dalbergia armata
D. obovata
Dioscorea sylvatica var. *paniculata*
Embelia ruminata
Entada pursaetha (only 1 massive specimen with some stems over 30 m long)
Grewia caffra
G. occidentalis
Jasminum multipartitum (upper parts)
Monanthotaxis caffra
Quisqualis parviflora
Rhoicissus tomentosa
Rhus nebulosa
Scutia myrtina (marginal)
Smilax kraussiana
Tecomaria capensis (upper parts)

In addition to *E. pursaetha*, a few of the other woody species have individuals that reach massive proportions. The largest of these, a *Dalbergia armata*, measured 11 cm diam. at approximately 1 m from the base.

Other less robust climbers, some of which reach the upper canopy in the lower more protected parts, include: *Capparis* sp. prob. *C. sepiaria* var. *citrifolia, Ceropegia linearis, Cissus fragilis, Coccinia palmata* (lower parts), *Dioscorea crinita, Ipomoea congesta* (lower parts), *Pyrenacantha scandens* and *Senecio tamoides.*

The only epiphyte that was recorded was a hemi-epiphyte, *Ficus burkei*, strangling an *Albizia adianthifolia.* Other specimens of *Ficus burkei* occurred as established trees, as listed above. Parasites are poorly represented on these mesoclines, the only species recorded was *Loranthus dregei* on woodland trees receiving adequate insolation.

4.2.2.2.2 Plant communities on dry slopes

The non-salt-spray communities that are discussed here include those on all slopes of the red-sand hills that are drier than the steep south-facing slopes, discussed above, and not merely the rather more arid north-western slopes.

Of all the communities on red sands these have been the most severely disturbed, as mentioned in the introduction to this section. The least amount of disturbance from cutting and burning has been on the steep inland-facing slopes of the main Isipingo Beach hill and Donsagolo where a rather dry type of forest has been able to become established; except where earlier land-slips have lead to the establishment of less mature communities.

4.2.2.2.2.1 Pioneer and herb communities

Non-vascular plants are unimportant or, more generally, absent as pioneers on these slopes.

Although there is variation in composition of the pioneer communities, depending upon environmental conditions, the more general components of the pioneer communities include:

Bulbostylis contexta
Carpobrotus dimidiatus (where not too dry)
Conyza canadensis
Cynodon dactylon
Cyperus natalensis
Eragrostis ciliaris
E. curvula
Fimbristylis hispidula
Helichrysum asperum
H. decorum
Imperata cylindrica
Limeum viscosum subsp. *viscosum* var. *kraussii*
Oenothera affinis
Panicum maximum
Rhynchelytrum repens

and, less commonly, *Acanthospermum glabratum* and *Richardia brasiliensis.*

These herbs form a mixed community, initially of rather scattered individuals. *Cyperus natalensis* frequently is locally dominant, often where reworked soil has become more sandy; in such situations *Imperata cylindrica* is frequently well represented or dominant later.

Many other herbs become established in these open pioneer communities. These include:

Aeschynomene micrantha
Asystasia gangetica
Barleria obtusa
Cassia plumosa var. *plumosa*
Ceratotheca triloba
Commelina africana
Dactyloctenium australe
Digitaria diversinervis (generally later, where shaded)
D. longiflora
Drimiopsis maculata
Ehrharta erecta var. *natalensis* (where not too dry, partly shaded)
Eragrostis capensis
Eulophia speciosa
Gloriosa superba
Hewittia sublobata
Kalanchoe rotundifolia var. *genuina*
Lagenaria mascarena (occasional)
Manulea parviflora
Mariscus dubius
Merremia tridentata subsp. *angustifolia*
Panicum chusqueoides (generally lightly shaded)
P. deustum
Perotis patens
Phaulopsis imbricata
Priva cordifolia var. *abyssinica*
Sacciolepis curvata
Senecio madagascariensis
S. variabilis
Sonchus integrifolius var. *integrifolius*
Tragia durbanensis
Vigna unguiculata
Wahlenbergia undulata

Another herb, *Crinum macowanii*, occurs in this community, but is not as common or as widespread as the majority of those listed above. *Bulbine asphodeloides* occurs also only occasionally on these slopes, a little later in grassland succession, but prior to the development of more robust invaders. More common of the early tall herb invaders are *Pollichia campestris, Senecio chrysocoma* and trailing forms such as *Rhynchosia caribaea* var. *picta* and *Smilax kraussiana.*

These form an open mixed community in which the grasses and sedges are the more abundant. In addition to these autotrophic plants, *Striga asiatica*, a hemi-parasite on roots also occurs occasionally in open grassland. *Panicum maximum* eventually becomes the dominant of this community particularly if fire is unimportant. Taller or more robust grasses such as *Hyparrhenia filipendula* var. *pilosa* and *Digitaria macroglossa* occur only occasionally on these slopes in the study area.

In addition to the few invaders mentioned above there are many other robust herbs and woody plants, trailing or erect, which invade open grassland. The most widespread of these, becoming dominant in parts, particularly on reworked sandy soils, is *Helichrysum kraussii*. This is a rather ericoid bushy suffrutex, occurring up to approximately 75 cm in height, although frequently much lower, which forms a low "scrub" prior to invasion by *Chrysanthemoides monilifera* subsp. *rotundata* or more robust woody plants. Other early herbaceous invaders occurring generally on better soils, or where not too dry, include:

Asparagus africanus
A. densiflorus
Celosia trigyna
Crotalaria grantiana
Helichrysum cymosum
H. panduratum
Hibiscus surattensis
Triumfetta rhomboidea
Vernonia angulifolia

The more common, and also the more shade-producing, are the *Helichrysum* spp. and *V. angulifolia*. These shade out the shorter heliophilous members of the herbaceous community immediately prior to scrub development.

4.2.2.2.2.2 *Scrub communities*

Several woody plants are able to become established in early open herb communities. However, in the initial stages of succession, in poor soils or with little protection from wind and other adverse factors, growth of these woody plants is relatively slow. As they eventually grow taller, the community changes to an open low scrub. With habitat improvement following the establishment of these initial shrubs or with the general successional changes mentioned in the last section, scrub encroachment or succession to more mature communities is more rapid. Furthermore, additional heliophytes are able to invade the more protected relict patches of grassland or early herb communities, thus accelerating closure.

The most widespread and abundant of these initial invaders is the fast-growing *Chrysanthemoides monilifera* subsp. *rotundata*. This weak-stemmed shrub, in spreading laterally as well as growing erect, shades out the heliophilous herbs. In addition to providing a habitat suitable for the later establishment of shade-tolerant or shade-dependent plants, it provides a good windbreak and therefore is of value to the heliophilous shrubs which are able to become established between bushes of *C. monilifera* subsp. *rotundata*. *Lantana camara* and the more herbaceous *Eupatorium odoratum*, both quick-growing plants, occur later in succession than *C. monilifera* subsp. *rotundata* on these slopes. Both, particularly *E. odoratum*, occur on more improved soils and are more important as invaders of patches of grassland reduced by advancing scrub or woodland. Both are of secondary rather than primary communities.

Amongst the other early woody invaders of grassland are the following species which occur as climbers or scramblers in more mature communities: *Rhus nebulosa, Grewia caffra, G. occidentalis, Dalbergia armata, D. obovata* and *Scutia myrtina*. Apart from the first mentioned, the others frequently occur as short self-supporting shrubs in open communities. *Ficus burtt-davyi* also spreads when in open herb communities and occurs more erect when others offer competition for sunlight; in closed communities it occurs as a scrambler reaching the upper canopy.

Brachylaena discolor is the most widespread of the invaders of the early communities. It is able to become established in poor, loose, sparsely covered soils. *Eugenia capensis*, not as common or as widespread as *B. discolor*, also occurs in the poorer sands. Early invaders occurring on soils showing varying degrees of improvement are:

Acacia sieberana var. *woodii*
Albizia adianthifolia
Canthium obovatum
C. spinosum
Carissa bispinosa var. *acuminata* (more common later and where shaded)
C. macrocarpa (where not too dry)
Dichrostachys cinerea subsp. *nyassana*
Diospyros lycioides subsp. *sericea*
Kraussia floribunda
Ochna natalitia
Psidium guajava (where not too dry)
Sclerocarya caffra
Strelitzia nicolai (where not too dry)
Strychnos spinosa
Tricalysia sonderana
Vangueria infausta

Other invaders of open grassland or mixed herb communities, becoming established somewhat later in the succession than the above, include:

Acacia robusta subsp. *clavigera* (occasional)
Acalypha glabrata (only near bases of red sand hills)
Antidesma venosum
Apodytes dimidiata subsp. *dimidiata*
Bersama lucens
Clerodendrum glabrum
Cordia caffra
Deinbollia oblongifolia
Putterlickia verrucosa
Sapium integerrimum
Xeromphis obovata
Ziziphus mucronata

These invaders initially form an open mixed scrub, in which there is variation in composition depending upon the environmental conditions. In the absence of fire, *Brachylaena discolor* grows rapidly on these slopes and soon assumes dominance. In addition to *B. discolor*, others of the above list also occur as trees in later communities, while several occur only as shrubs in open situations, as discussed below.

Subordinates in the scrub communities include the more shade-tolerant herbs of the earlier communities together with the few herbs mentioned under early woodland communities (see next section). Climbers and scramblers include the scandent forms already listed together with *Acacia kraussiana, Capparis sepiaria* var. *citrifolia* and *Dioscorea diversifolia.*

4.2.2.2.2.3 Woodland communities

As the taller members of the scrub communities increase in size sufficiently to be considered trees the communities grade into woodland. With increase in size of the dominants as well as with the establishment of additional species, there is continuous closure of the open parts. The shorter obligate heliophytes die out and shade-dependent seedlings of various plants are able to become established; this continuous process leads eventually to the establishment of more complex woodland communities and eventually to forest.

It has been mentioned already that *Brachylaena discolor* is an important constituent of these early woodland communities. In addition to *B. discolor, Albizia adianthifolia* is also very common. This species eventually overtops *B. discolor* and, with its widely-spreading crown, becomes the dominant in later woodland communities.

Other trees in woodland communities include:

Acacia robusta subsp. *clavigera*
Acacia sieberana var. *woodii*
Allophylus natalensis
Antidesma venosum
Apodytes dimidiata subsp. *dimidiata*
Bersama lucens
Canthium obovatum
Clerodendrum glabrum
Cordia caffra
Ekebergia capensis
Erythrina lysistemon
Euclea natalensis
Millettia grandis
Mimusops caffra
Sapium integerrimum
Sclerocarya caffra
Sideroxylon inerme
Strelitzia nicolai (where not too dry)
Strychnos decussata
Ziziphus mucronata

Shorter trees and shrubs which occur in the open parts include those listed for the scrub communities together with the following:

Acalypha glabrata (generally lightly shaded and only towards base of hills)
Allophylus melanocarpus (sometimes lightly shaded)
A. natalensis (initially lightly shaded)
Bauhinia tomentosa
Canthium inerme
C. locuples (marginal and only on steep north-western slope)
Cestrum laevigatum (generally where directly disturbed by man)
Dovyalis rhamnoides (more generally shaded)
Ehretia rigida
Lasiosiphon meisnerianus (rare)
Mitriostigma axillare (lightly shaded)
Pavetta alexandrae (generally lightly shaded)
Rhus natalitia
Turraea floribunda

Those which occur in shade include those specifically mentioned in the above list together with:

Baphia racemosa (generally later in succession)
Carissa bispinosa var. *acuminata*
Clausena anisata
Dracaena hookerana (generally short enough to be included rather in the field layer)
Deinbollia oblongifolia
Eugenia natalitia
Lagynias lasiantha (generally scandent)
Psychotria capensis
Putterlickia verrucosa
Rothmannia globosa (generally later in succession)
Trimeria grandifolia (generally later in succession)
Xeromphis obovata (light shade)
X. rudis (light shade, occasional)

Herbs or suffrutices are not well represented in the woodland communities on these drier slopes. Marginal communities, however, are relatively well developed and contain members of the earlier open communities as well as such additions as *Eupatorium odoratum* and *Peristrophe natalensis* or, generally where disturbed, *Achyropsis leptostachya* and *Pavonia dregei.* Occurring more rarely is *Hibiscus physaloides* and, where not too dry, *Vernonia adoensis.* The field layer within the woodland communities is poorly developed, although this varies with aspect and the amount of shade cast by the taller constituents. In the early stages of woodland development, particularly where only lightly shaded, a few grasses and other herbs occur. The grasses include relict *Panicum maximum* and, more commonly, *P. deustum* as well as the creeping grasses *Dactyloctenium australe, Digitaria diversinervis* and *Panicum chusqueoides. D. australe* often forms the dominant cover in these early stages of woodland development. Occurring with these are commonly *Australina acuminata, Chlorophytum modestum, Cyperus albostriatus, Haemanthus magnificus* (nowhere abundant), *Psilotrichum africanum* and *Sansevieria hyacinthoides.* Near the bases of these hills, where conditions are more moist, *Achyranthes aspera* is common is shade and, locally so, is *Rivina humilis.* As the shade increases these, except for *S. hyacinthoides,* mostly die out, while additions occur such as *Coleotrype natalensis, Dicliptera heterostegia, Isoglossa woodii* and, rarely, *I. ciliata.*

Climbers and scramblers are well represented. A few have been listed already as invaders of open herb communities; some of these, such as the herbaceous *Hewittia sublobata* and *Vernonia angulifolia,* occur rather more abundantly in shorter woodland or scrub, whereas the woody forms already mentioned extend into the upper canopy of even the taller communities. In addition to these, other climbers and scramblers of woodland communities include:

Asparagus falcatus var. *falcatus* (generally later)
A. setaceus
* *Capparis tomentosa*
Cissus fragilis
Coccinia palmata
Cynanchum ellipticum (mostly marginal)
* *Cyphostemma hypoleucum*
Dalechampia capensis (marginal)
Dioscorea crinita
* *Diospyros villosa* var. *villosa*
* *Embelia ruminata*
* *Flagellaria guineensis*
Jasminum multipartitum
Microglossa mespilifolia (early stages only)
Monanthotaxis caffra
Plumbago auriculata (early stages only)
* *Rhoicissus tomentosa*
Senecio brachypodus (mostly in early stages)
S. tamoides (later)
Tecomaria capensis (mostly in early stages)
Tinospora caffra
Uvaria caffra (mostly later)

While any of the climbers which extend into the canopy increase the shade effect on the lower plants, several of the more robust species offer serious competition to the trees, especially the heliophilous precursors such as *Brachylaena discolor* and *Albizia adianthifolia.* Species commonly offering such competition to the taller precursors include those marked * in the list above as well as the following which occur also earlier in the succession: *Acacia kraussiana, Dalbergia armata, D. obovata* and *Grewia caffra.* In addition to providing direct competition to the heliophilous species, these climbers contribute to the creation of a more suitable environment for the establishment of forest species.

No vascular epiphytes have been recorded from these woodland communities, other than two hemi-epiphytes. These are *Ficus burtt-davyi* (very common) and *F. natalensis* (occasional). *F. burtt-davyi* in early succession generally occurs as a terrestrial scandent shrub; in later stages of succession it often germinates on a taller woody plant, but only seldom strangles its support. *F. natalensis* does not appear as early in the succession as does *F. burtt-davyi* and it generally strangles its supporting tree.

Loranthus dregei and, more infrequently, *L. kraussianus* occur occasionally as partial parasites in these communities.

Trees occurring later in these communities include *Celtis africana, Chaetachme aristata, Commiphora harveyi, Croton sylvaticus, Fagara capensis, Scolopia zeyheri* and *Strychnos madagascariensis* whose seedlings develop in the shade of the earlier trees. These are regarded as being Coast Forest initials. With the establishment of these trees, the precursors, particularly *B. discolor*, are shaded out and the community grades into Coast Forest (see Section 4.5). Of the trees listed above the most common in the early stages of Coast Forest development is *Celtis africana. Croton sylvaticus* also plays a prominent role in a similar stage, but, in the study area, it is limited to Athlone Park and, as mentioned, to Jeffels' Hill.

4.2.2.2.3 Subseres

It is considered that secondary succession on these soils and under the influence of the other environmental factors of the study area are basically similar to the primary succession, particularly on the drier slopes. Much depends, however, upon the degree of disturbance to the original vegetation and soils, as well as upon the extent of the disturbance. Peripheral relict vegetation protects small areas better from the subsequent action and wind, water and solar radiation than it is able to do where large areas are disturbed. The ecological status of the original community also influences the secondary succession following disturbance: organically improved soils are re-covered more rapidly than the poorer soils, although, as mentioned, the degree of exposure to various environmental factors governs this as well.

An early effect of clearing is an increase in ruderals, both annuals and perennials, amongst which are a large number of naturalized aliens. These are better developed on the relatively moist slopes than on the drier slopes. These subseral communities also exhibit various stages in succession, depending upon the factors mentioned above, until they are eventually replaced by primary communities.

Where these is repeated disturbance, subseral communities, particularly in early stages of succession, differ from those of the primary succession. Repeated fires, for example, permit the development of more extensive or more complex grassland communities than is the case where fire is not an important environmental factor.

Scrub and woodland communities are likewise affected, not only in composition, but also in physiognomy, depending upon the degree of repetition and severity of the fires. *Chrysanthemoides monilifera* subsp. *rotundata* is progressively reduced with an increase in fires. Furthermore, rather than scrub communities grading into woodland communities, as suggested earlier, thickets are formed where fire is not too severe a factor. These thickets are dominated by one or more trees which are either relicts of former more mature communities or are the more heliophilous precursors such as *Brachylaena discolor.* The composition of the thickets depends upon the history of the burning practice. The spread or further reduction of the thickets depends upon the incidence of further fires. With an increase in fires, *B. discolor* and similar mesic precursors are reduced while fire-tolerant shrubs such as *Dichrostachys cinerea* subsp. *nyassana, Vangueria infausta* and *Diospyros lycioides* subsp. *sericea* become relatively more important, as do also such trees as *Acacia sieberana* var. *woodii* and *Sclerocarya caffra.* Among the more fire-tolerant of the other woodland species, listed earlier, are *Ziziphus mucronata, Millettia grandis, Sideroxylon inerme* and *Erythrina lysistemon.*

4.2.2.2.4 Community interrelations

Interrelations of the various communities have been discussed throughout Section 4.2.2.2 and the seral communities are illustrated in Fig. 38. Forest communities are discussed later under Section 4.5.

Grassland communities on these red sands have been continously reduced since well before the beginning of this investigation; today they are virtually absent. Nevertheless data, obtained from relicts at the beginning of this investigation and from comparative studies made since then, have led to the suggestion that the scheme given in Fig. 38, with the exception of the *Cestrum laevigatum* and *Lantana camara* communities, represents the interrelations of primary communities. *L. camara* has been introduced because of its considerable importance under present conditions. *C. laevigatum* scrub is included because of its local significance in moister parts.

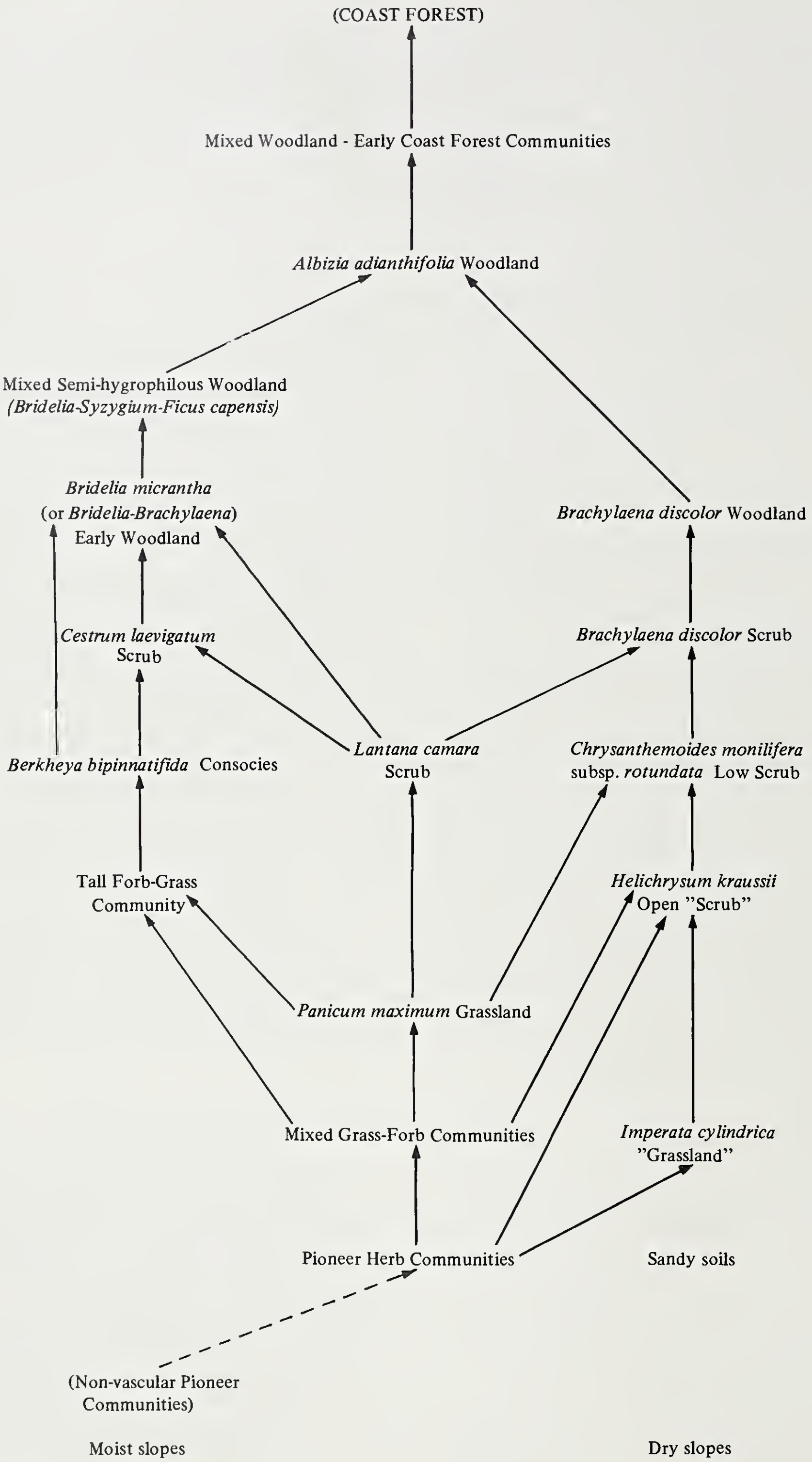

(COAST FOREST)
Mixed Woodland - Early Coast Forest Communities
Albizia adianthifolia Woodland
Mixed Semi-hygrophilous Woodland
(Bridelia-Syzygium-Ficus capensis)
Bridelia micrantha
(or *Bridelia-Brachylaena*)
Early Woodland
Brachylaena discolor Woodland
Cestrum laevigatum
Scrub
Brachylaena discolor Scrub
Berkheya bipinnatifida Consocies
Lantana camara
Scrub
Chrysanthemoides monilifera
subsp. *rotundata* Low Scrub
Tall Forb-Grass
Community
Helichrysum kraussii
Open "Scrub"
Panicum maximum Grassland
Mixed Grass-Forb Communities
Imperata cylindrica
"Grassland"
Pioneer Herb Communities
Sandy soils
(Non-vascular Pioneer
Communities)
Moist slopes
Dry slopes

FIG. 38 - Suggested interrelationships of seral communities on red sands where salt-spray is not a limiting factor

4.3 HALOSERE

Mangroves and herbaceous halophytes are well represented in the estuarine areas of the Sipingo and former Mlazi Rivers. Only a few facultative halophytes, or halophytes tolerant of extreme salt dilution and prolonged inundation, are able to survive on the banks of the Mbokodweni Lagoon.

The main environmental factors of these areas have been mentioned already (see, in particular, Sections 1.3, 1.4 and 2.4.1). Briefly, the plants in the intertidal areas are subjected to continuous fluctuations of water level, flow rate and salt concentration. These fluctuations vary in amplitude and are due to various tidal movements, and are further influenced by the occurrence of rains, floods or droughts.

With the diversion of the Mlazi River in 1952, the major source of supply of freshwater and alluvium to the Sipingo Estuary was removed. Due to the reduction in river flow, the mouth frequently became blocked by a sand bar. This resulted in a brack to almost freshwater lagoon being formed which inundated the low-lying parts for prolonged periods. Such lagoon formation was atypical for this particular estuary which was generally open to the sea.

Blockage of the estuary mouth for relatively short periods occurred prior to the 1952 diversion, particularly during droughts in the later 1940's and early 1950's. Such low flow during these periods was, no doubt, aggravated by the earlier (1946-1947) diversion of water from the north-eastern parts of the Isipingo Flats into a canal opening into the sea at Reunion Rocks. Drainage pipes through the sand bar at the river mouth, introduced originally in 1955, prevent large-scale prolonged inundation. At the same time,

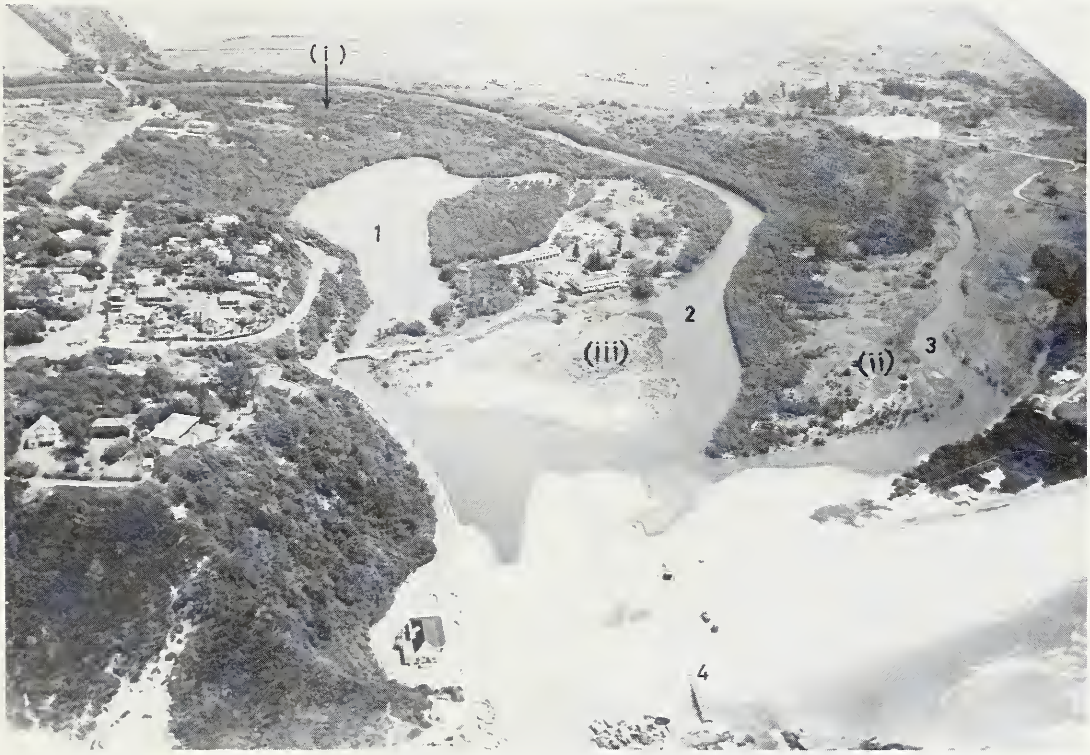


FIG. 39 - Aerial view of Sipingo Estuary and Lagoon, 1965. Photo taken just prior to destruction of low-lying vegetation and infilling of area from hotel, in centre, to main road in left distance. 1. Lagoon. 2. Sipingo Estuary. 3. Estuary of former Mlazi River. 4. Piped outlet beneath wave-deposited sand.

Mangroves merging into low-lying scrub, woodland or early forest communities in vicinity of lagoon and along whole length of estuary and Sipingo River; except (i) beyond lagoon and to right of building in left background where *Juncus kraussii* salt marsh developed, (ii) on lower alluvial spit between Sipingo and Mlazi channels where communities younger or substrate higher and (iii) in front of hotel where former mangroves and, periodically, invasions of younger mangroves destroyed by man.

Also shown: disturbed southern extremity of dune scrub and woodland on white sands of Isipingo North, right foreground; unstable slope and wind-trained canopy of Closed Maritime Scrub on steep seaward slope of main Isipingo Beach hill, left foreground; vegetation almost closed on slope above tea room towards left foreground, formerly open and highly unstable until 1910 (date of completion of wall at base of hill); Isipingo Flats with Road Party Camp and sugar-cane field in far background the pipes restrict the inflow of sea-water during those times when the natural mouth is blocked, a feature which occurs with considerable frequency and for long periods nowadays. The concrete pipes (see Fig. 39), introduced in 1961, have their landward bases 30 cm above Trigonometrical Mean Sea Level and each of the two pipes has an internal diameter of 112 cm.

Even when the river mouth is open to the sea the lowest levels are not necessarily always reached at low water in the estuary, since sand deposition in the mouth may prevent complete emptying before the tide starts to rise again.

In addition to alluvial material of different types being deposited in the estuary by river action, washed sand is also deposited in the lower estuary by incoming tidal action. This material not only aids siltation unless it is removed by river action, but also, drying readily when exposed, it is liable to be driven further by wind. Wind also introduces additional material directly from the uncolonised strand.

Another locally important effect of wind is that it influences the transportation and deposition of floating debris and propagules of various estuarine plants, including those of the mangroves.

Altitude and topographical gradient are particularly important in the estuarine areas, since, directly and indirectly, these affect drainage, aeration and local salinity. As discussed in Section 1.4, the higher deposits, especially those above tidal reach, eventually become sandier whilst the lower parts become more clayey. The latter is due not only to illuviation of the finer particles from the upper parts, but also to the ability of clay particles to settle after flocculation in saline water.

The more important biotic factors influencing specifically the halophytes and their succession include man, in that he has changed drainage patterns, infilled a great proportion of the former intertidal area and, in parts, has cut out established vegetation. Of the various invertebrates, those having the greater impact include crabs (see also Section 5.2.2.1) since, by burrowing, they improve aeration and drainage and they raise the level of the substrate thus reducing, or eliminating, the period of inundation by tidal water (see Fig. 40); furthermore, they improve the organic content of the soil and effect local soil turnover; indirectly they aid particle size sorting by rain water. Waders and sea-birds contribute to the enrichment of the substrate, more noticeably in the lower estuary where the latter, in particular, often accumulate in large numbers on low uncolonized sand banks.

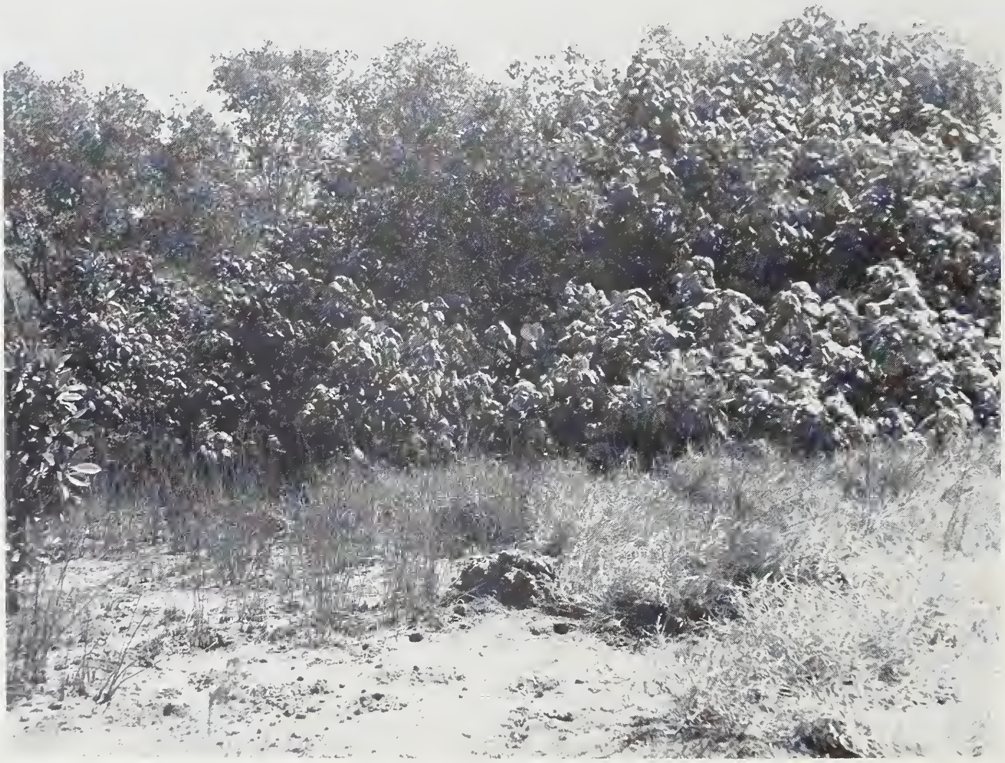


FIG. 40 - Later stages in halosere and effect of crabs. Several *Sesarma meinerti* burrows with excavated mud in foreground. Large crab mound (sealed burrow) in centre approx. 20 cm tall.
Tall *Avicennia marina* in lower-lying parts. Shorter *Bruguiera gymnorrhiza* extending to higher parts. *Hibiscus tiliaceus,* above mangroves, spreading and shading out *Stenotaphrum secundatum* and slightly lower *Juncus kraussii.* In shade under *H. tiliaceus* and on raised sandy substrate (muddy sand with organic debris) are *Scutia myrtina, Phoenix reclinata* and, as a relict from early open conditions, *Eugenia capensis*

4.3.1 Communities in permanent water

Algal communities have not been studied in detail. The largest alga is a filamentous Chlorophyta (*Cladophora* sp.) which occurs periodically in the lower estuary. With tidal action, strands of this alga are often caught on the pneumatophores of *Avicennia marina*, thus interfering with water flow and causing deposition of water-borne material. *Caloglossa* sp. (Rhodophyta) has been recorded as an epiphyte on submerged pneumatophores of *Avicennia marina* after prolonged blockage of the river mouth.

The only submerged angiosperm recorded was *Zostera capensis*. This formed small mats on a muddy substrate in a former channel of the Sipingo River in the lower estuary. At the time of collection, the mouth was temporarily blocked and the water was approximately 75 cm deep. Had the mouth been open, this consocies would have been in very shallow water or just exposed at extreme low water spring tide. This community which was very localized died out and has not been recorded since shortly after specimens were originally collected in 1948. The interwoven rhizomes and roots of this plant aided stabilization of submerged banks, while the leaves probably helped in effecting deposition of finer material.

Under conditions of a fully opened mouth and with an interchange of sea-water with fresh or brackish waters, all the other estuarine vascular plant communities occur upwards from a little above high water ordinary neap tide. Those that occur in apparently permanent water in the study area are those that are tolerant of prolonged basal inundation subsequent to their original establishment on exposed substrates; also the inundation is due to an impediment in drainage, not to altitudes below mean sea-level. Such waters are generally of reduced salinity, although, as mentioned, the concentration varies considerably. Where salinites and water flow have been much reduced, *Phragmites australis* extends into permanent water by vegetative growth. Others tolerant of prolonged basal inundation are *Scirpus littoralis, Rhizophora mucronata* and *Avicennia marina*. These are dealt with in the next section.

4.3.2. Intertidal communities

The term, intertidal, is used here in its broadest sense. Included are those communities occurring in situations that are covered by exceptionally high tides as well as those that are covered by ordinary tidal fluctuations.

Pioneers vary with corresponding variation in the environmental factors of which salinity and drainage would appear to be particularly important. Successful colonization leads to stabilization of the substrate and deposition of further material by reducing the velocity of water or wind. This, in turn, generally leads to the establishment of more mesic communities on the higher ground. Deposition of wind- or water-borne material, however, sometimes causes a change in the local drainage pattern on the landward side of the deposition. One result of such an impediment to drainage is the development of marshy conditions and sometimes an increase in salinity with consequent changes in the local vegetation, whereby halophytes are able to invade more mesophytic communities.

4.3.2.1 ALGAL COMMUNITIES

On estuarine banks which are not subject to excessive surface desiccation various Cyanophyta, or other microscopic algae such as diatoms, occur as pioneers. Since exposed washed sand dries readily these algae occur on silt or clayey substrates, unless there is an additional source of water supply together with some form of organic enrichment. Often algae occur only as a very thin film on the substrate. They may, however, be extensive, and felt-like mats of filamentous Cyanophyta, in particular, aid in stabilizing the substrate.

4.3.2.2 HERBACEOUS VASCULAR PLANT COMMUNITIES

4.3.2.2.1. Pioneer communities

Although herbaceous halophytes frequently appear earlier than mangroves on newly exposed banks of sand or sandy mud in the estuary, they are not necessarily more salt-tolerant than mangroves. On the contrary, most are apparently less salt-tolerant, but, being quicker growing, the pioneer herbs are often able to become established on exposed banks before the mangroves; particularly during the rainy season when salt concentrations are low. While they may die out later due to seasonal changes in the environmental factors, they play an important role in stabilization and in deposition of material.

Juncellus laevigatus is frequently the most important of the pioneers of exposed silt-covered sand or sandy mud following deposition of silt from summer river flow. Under normal estuarine conditions, that is, when the mouth is open, this rhizomatous herb often forms an open community (see Fig. 41) which is ephemeral in the lower-lying parts. *J. laevigatus* dies out later in the non-rainy season, probably due to an increase in salinity. Frequently *Triglochin striata* and *Arthrocnemum natalense* var. *natalense* occur as associates of *J. laevigatus* and, if conditions are initially more saline, these two are the more important colonizers, sometimes occurring to the exclusion of *J. laevigatus*. *Triglochin striata* is most frequent in saline sandy mud not subjected to excessive desiccation. This species is also the most shade-tolerant of these three pioneer herbs; even so,

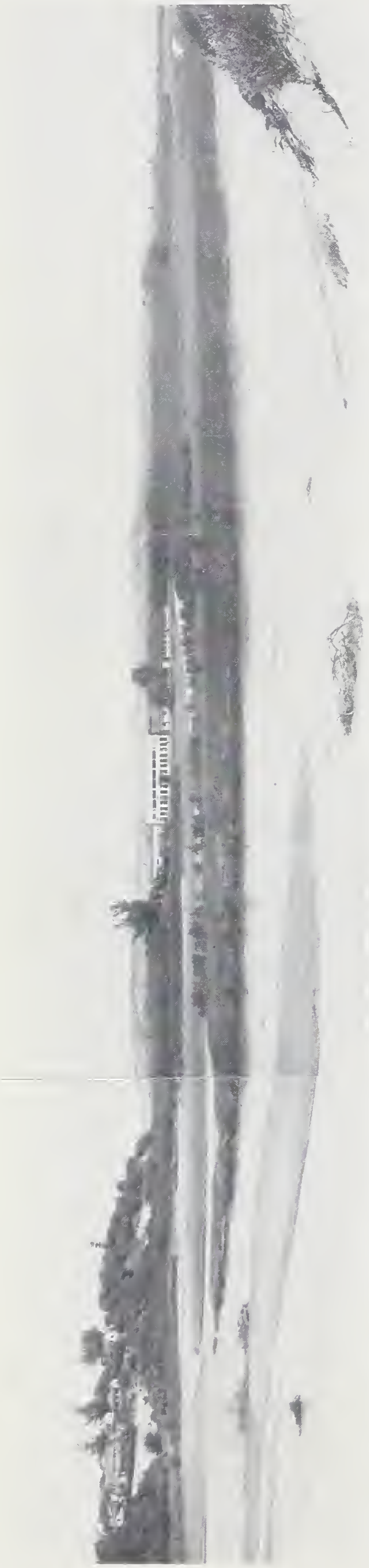


FIG. 41 - Early communities on alluvial deposits in estuary, Isipingo, 1950 (see also Fig. 46). Mlazi River in foreground; Sipingo River on further side of alluvial spit; entrance to blind lagoon far left. Differences in communities on two sides of spit due to greater freshwater flow from Mlazi River. From left: *Triglochin striata* at extremity of spit, slightly taller *Juncellus laevigatus* (dark) and *Sporobolus virginicus* (light) invaded by taller *Juncus kraussii* and *Scirpus littoralis*, slightly higher or fresher. *Scirpus littoralis* Consocies (dark) on near side of spit, increasing in size further up-river to right where later replaced by *Phragmites australis* (light). *Arthrocnemum natalense* var. *natalense* on further side of extremity and in lower central part. Halophilous grasses covering greater part of central spit, *Paspalum vaginatum* becoming dominant, giving way to *Stenotaphrum secundatum* on raised parts (far right and immediately beyond *S. littoralis* in centre). Scattered clumps of *Juncus kraussii* (dark) towards upper limits of halophilous grasses. Beyond Sipingo River, ephemeral *Juncellus laevigatus* pioneer community on silt-covered alluvial bank. *S. virginicus* on higher sandier parts (paler substrate in distance). *Avicennia marina* Scrub in distant lower parts and invading alluvial spit from Sipingo side. Several smaller *Bruguiera gymnorrhiza* on spit, particularly where slightly higher or fresher than main *A. marina* Consocies

it is tolerant of only light shade. *Arthrocnemum natalense* var. *natalense* becomes the dominant where the substrate is muddy and subject to long periods of dryness. It is not tolerant of prolonged inundation, especially if the water is saline. It sometimes forms pure stands on saline flats above mean high water or even higher and it frequently occurs on mud where mangroves have been cut out.

Where conditions are moist and salinities are reduced through a fresh water influx, *Scirpus littoralis* is generally the main pioneer. It often forms extensive pure stands, particularly where water is not standing (see Fig. 41). *S. littoralis* acts as a very efficient stabilizer of recently deposited alluvium. Although it is tolerant of inundation by tidal water (measured to 31 ‰) at high spring tides, it is not tolerant of continuous high salinity. Furthermore, it is not as tolerant of prolonged basal inundation as is *Phragmites australis* which frequently invades *S. littoralis* Consocies if there is a decrease in overall salinity. *P. australis* also appears to be more tolerant of conditions associated with reduced water movement.

The pioneer communities mentioned above are liable to be invaded by mangroves or, with a change in soil level and salinity, succession may lead to other herbaceous communities progressively less frequently covered by tidal waters.

4.3.2.2.2 *Phragmites australis* Brack-water Consocies

The most extensive development of *P. australis* Consocies in the study area occurs in the form of freshwater reedswamp, at least it did until the recent and current destruction of the habitat. This is dealt with in Section 4.4.2, but, in view of the presence of stands of this species at a low altitude, sometimes lower than that at which true halophytes occur, it is mentioned briefly here.

Where there has been a dilution of salt water, although temporary inundation by water up to 30‰ has been recorded, *P. australis* often forms pure stands. These stands generally originate on exposed substrates, but they tolerate prolonged basal inundation (see Fig. 42). Under these circumstances the flow rate of the water is generally much reduced. Extension of the consocies is by means of rhizomes.

Under brackish water conditions the associates and subordinates of the freshwater reedswamp are absent. The only "associate" (but really a precursor in this succession) is *Scirpus littoralis*. This species generally occurs where there is a higher salinity or more flow; with progressive lowering of salinity, especially if this is accompanied by reduced flow, *P. australis* eventually ousts *S. littoralis*.

Plant succession from *P. australis* Brack-water Consocies leads along three major paths. Firstly, there may be a direct invasion by mangroves, particularly if there is a local increase in salinity and if the substrate is exposed at times following dispersal of the propagules; within reasonable limits, however, these requirements are not obligatory. Secondly, with an increase in deposition of sandy alluvium (generally from flood waters), so that the level of the soil is raised above maximum tidal level, this consocies may be invaded by riparian grassland in which *P. mauritianus* is an important early constituent. Thirdly, under lightly brackish conditions and with a rise in soil level, generally with a substrate of sandy mud, the consocies is either invaded directly by *Hibiscus tiliaceus* or it is replaced by *Stenotaphrum secundatum* Grassland. Fig. 43 illustrates some of the stages mentioned above.

4.3.2.2.3 *Sporobolus virginicus* - *Paspalum vaginatum* Grassland

With an increase in soil level, *Sporobolus virginicus* and *Paspalum vaginatum* invade the pioneer *Juncellus-Triglochin-Arthrocnemum* associes. Whilst the two grasses often occur together, *S. virginicus* is dominant on sandy soils, whereas *P. vaginatum* is dominant on muddy soils.

This associes, or either facies, generally indicates the upper limit of ordinary spring tide.

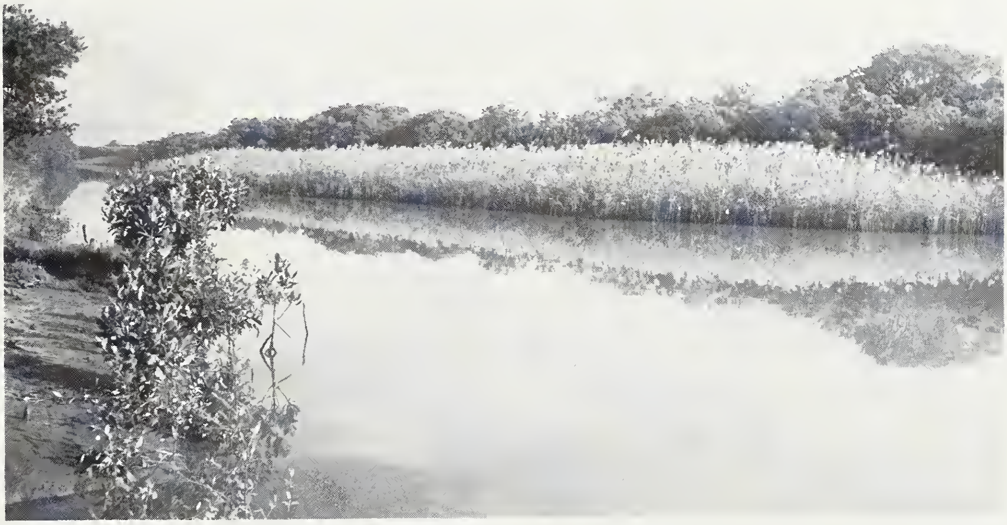


FIG. 42 - *Phragmites australis* Consocies in tidal Sipingo River, established after siltation from floods approx. 23 years prior to photo. Outgoing tide, drainage impeded, salinity 6 ‰ (mostly low, but to 30 ‰ here). On left: young *Avicennia marina* and *Rhizophora mucronata* in water and at water's edge; *Bruguiera gymnorrhiza* at edge and above; *Arthrocnemum natalense* var. *natalense* on bare mud above saplings. Far bank: *A. marina* emergent, *B. gymnorrhiza* continuous canopy; more distant *A. marina* closed canopy

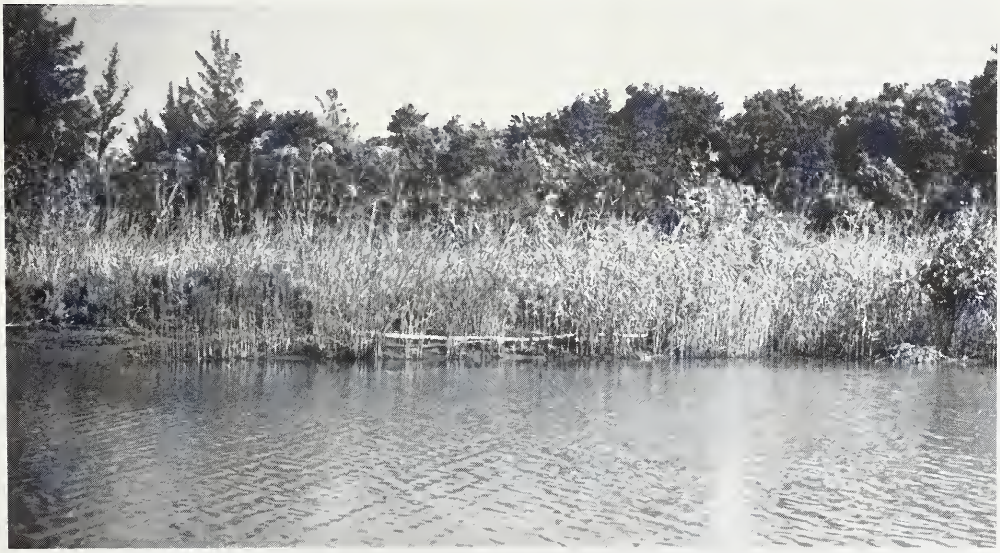


FIG. 43 - Estuarine communities on bank of former Mlazi River; mouth to left. At water's edge, from left: *Scirpus littoralis, Phragmites australis* and invading *Bruguiera gymnorrhiza.* On bank above tidal level: *Stenotaphrum secundatum* dominant grass on left; young *Hibiscus tiliaceus* on flood-plain; *Phragmites mauritianus* on left to almost centre. *Phoenix reclinate* right centre. In background: closed low-lying woodland - early forest communities

With a reduction in salt water these grasses sometimes occur slightly below this level or, in the absence of other invaders, at higher levels.

More generally this associes is rather limited in extent, but where the topography is flat and accretion slow the grassland formed by either or both of these two species is wider spread.

In sandy mud or silt-covered sand, slightly above high water ordinary spring tide, *Fimbristylis ferruginea* occurs as an associate or, where soils are moister (with a freshwater influence), as a local dominant.

4.3.2.2.4 *Juncus kraussii* Communities

Occurring in clumps with the above grasses at approximately high water ordinary spring tide, and becoming dominant slightly above this level, is *Juncus kraussii.*

A few forbs occur as subordinates (in size rather than in dependence) where the *J. kraussii* Consocies is open. Apart from the already mentioned *Arthrocnemum natalense* var. *natalense, Paspalum vaginatum* and *Sporobolus virginicus*, others which occur slightly above high water ordinary spring tide are *Triglochin bulbosa* and *Chenolea diffusa. T. bulbosa* is generally on moister and more clayey soils than *C. diffusa* which is not as common or as widespread as the others mentioned above.

On poorly drained soils, periodically flooded by very high tides, *J. kraussii* forms a denser community, from which other species are frequently excluded (see Fig. 44). In such places the *J. kraussii* Consocies represents a slightly more mesic stage in succession leading from *Arthrocnemum natalense* var. *natalense* Consocies rather than from the halophilous grasses.

With an increase in soil level so that inundation by tidal water is extremely occasional, or not at all, *J. kraussii* Consocies is invaded by *Hibiscus tiliaceus* or it gives way to *Stenotaphrum secundatum* Grassland. Prior to this, a tall herb, *Nidorella linifolia,* occurs frequently at the upper margin of *J. kraussii* Consocies in brackish muddy soils.

Where there is a better supply of fresh water although conditions are still brackish, invasion by the robust fern, *Acrostichum aureum*, sometimes takes place.

There is frequently much biotic interference with stands of *J. kraussii.* The stems are cut almost to ground level by Blacks who use this material for weaving traditional sleeping mats. Such action favours invasion by other plants, particularly herbs.

4.3.2.2.5 *Acrostichum aureum* Consocies

This is mentioned here purely to emphasize one of the later stages in succession following *J. kraussii*-dominated salt-marsh communities (see above). In the study area, *A. aureum* was extremely localized, being relatively sparsely spread over an area of less than 0,1 ha. Drainage or clearing for agricultural purposes which took place long before the beginning of this investigation possibly limited the upper distribution of this community. Recent industrial development has caused the complete destruction of the community and its habitat.

In sandy mud where salinity was extremely reduced and conditions were not too dry, *A. aureum* locally dominated the upper limits of the *J. kraussii* Consocies. This eventually shaded out *J. kraussii* in limited places. In the same vicinity, *A. aureum* occurred marginal to, and within, *Bruguiera gymnorrhiza* Consocies.

4.3.2.2.6 *Diplachne fusca* Consocies

D. fusca, a tufted grass, becomes locally dominant in relatively moist, lightly brackish situations in sandy mud and sands at the upper limit of, or just above, *J. kraussii* Consocies. *D. fusca* forms pure stands in parts, but these are generally of limited extension.

In recent exposures or depositions of sandy alluvium in brackish areas, *D. fusca* is often one of the pioneers, provided that the situation does not become too dry or subjected to increased salinity.

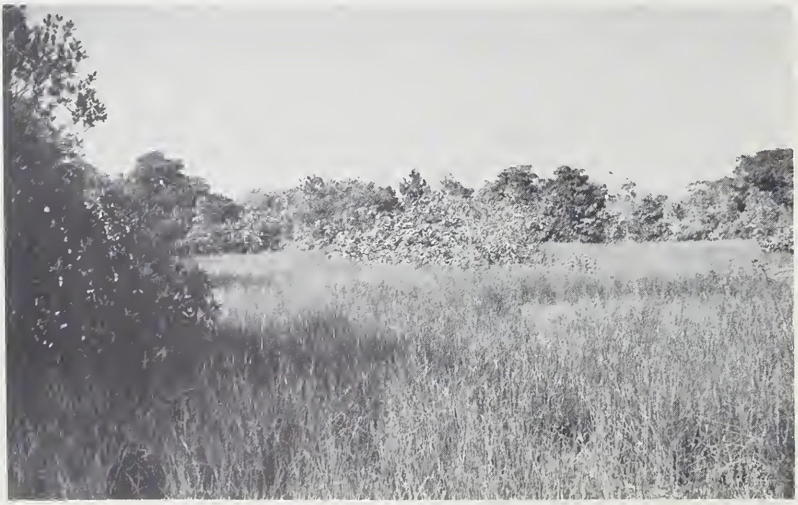


FIG. 44 - *Juncus kraussii* brack marsh on poorly drained flats occasionally receiving water from very high tides. Invasion by mangroves in lower parts. *Hibiscus tiliaceus* stunted on slight elevations, taller and faster-growing where salinity less and drainage better, marginal to distant woodland-forest

4.3.2.2.7 Ephemeral upper-intertidal communities

Where there is bare ground caused by fluctuations in water level at the uppermost limit of ordinary spring tide or slightly above this level, a bushy annual herb, *Atriplex patula* subsp. *verreauxii*, forms an ephemeral (spring-autumn) consocies. This is generally at the lower margin of *Stenotaphrum secundatum* Grassland although, in the absence of salt-water inundation, individuals frequently occur at lower levels in dried mud.

In similar exposed situations, in open communities or, rarely, where lightly shaded, but where conditions are slightly moister and fresher, *Aster squamatus*, another annual herb, occurs seasonally (in summer to late autumn). *Ethulia conyzoides* occurs in similar lightly brackish situations where not shaded. This occurs frequently in *Stenotaphrum secundatum* Grassland.

4.3.2.2.8 *Stenotaphrum secundatum* Grassland

This grassland is best represented a little higher than the upper limit of ordinary spring tides. The dominant, *Stenotaphrum secundatum*, a stoloniferous heliophyte, is tolerant of occasional salt-water inundation, but is killed if this inundation is prolonged or too frequent. This grassland occurs also on the Isipingo Flats above the limit of exceptionally high tides where soils are moist, at least periodically so, and are an admixture of sand and mud. In these latter situations it is frequently subseral.

In the lower-lying parts occupied by this grassland, *S. secundatum* frequently forms an associes with *Fimbristylis ferruginea* as a co-dominant. Associated with these, but less frequent are *Triglochin bulbosa, T. striata* (in moister and more saline places), *Pycreus polystachyos, Fimbristylis obtusifolia* and, where there is an additional freshwater influence, *Apium graveolens*.

Above this associes, or at the same level if soils are better drained, *S. secundatum* generally forms a dense sward from which the above associates are excluded. This consocies is invaded by woody plants or, where soil levels are slightly higher, by more mesic grasses, sedges and forbs. The first of the grass invaders is generally *Imperata cylindrica* which is dealt with later. The woody invaders vary with altitude and the nature of the substrate. In the lower-lying parts, an occasional invader is *Bruguiera gymnorrhiza*; a common invader, however, is *Hibiscus tiliaceus* which generally occurs at higher levels than *B. gymnorrhiza*. Where conditions are mesic or moist, with water fresh or nearly so, the invaders are precursors of riparian woodland. In drier, sandier situations the invaders are frequently early dune shrubs. (See Figs 40, 43 and 45).

4.3.2.3 WOODY PLANT COMMUNITIES

4.3.2.3.1 Mangroves

Three species of mangrove occur in the study area: *Avicennia marina, Bruguiera gymnorrhiza* and *Rhizophora mucronata*.

Although characteristics of each species are discussed individually in the Check-list, a few general features are mentioned here briefly.

Their rooting systems are well adapted to their semi-aquatic environment; they are shallow, fundamentally radiating and well provided with air spaces.

All three are viviparous, an adaptation, suggested by Joshi (1933), for overcoming the deleterious effect of salt on germinating seedlings; it also aids successful establishment to be made under aquatic conditions. Such features as length of hypocotyl (particularly in *B. gymnorrhiza* and *R. mucronata*), self-erection of seedlings, various means of protection to the stem apex or relatively rapid stem elongation after establishment of the roots reduce the period in which the stem apex is subject to inundation by salt water.

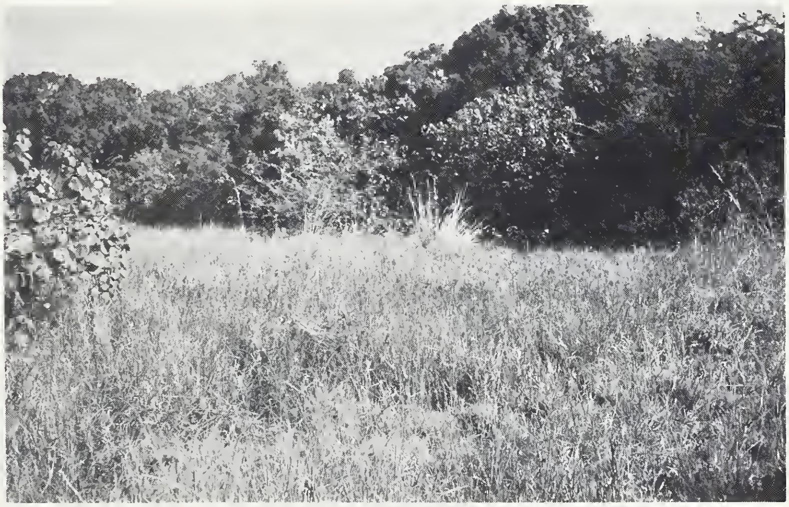


FIG. 45 - Forest precursor communities invading upper Juncetum, with slight increase in soil level. In foreground: *Juncus kraussii* invaded by *Hibiscus tiliaceus* (left) and stoloniferous *Stenotaphrum secundatum,* in turn invaded by *Imperata cylindrica,* followed by taller tufted grasses (*Digitaria macroglossa* initially dominant). Large tufts are *Cymbopogon validus.* Invading woody plants include *Dichrostachys cinerea,* left centre. Closed early forest communities on slightly raised ground in background. Emergent *Protorhus longifolia* far left and centre

Propagules of mangroves are water-distributed. In the absence of sufficient water for transportation they become established directly where they fall from the parent plant, if other factors permit. Seedlings of *B. gymnorrhiza* and *R. mucronata*, both with elongated naked hypocotyls, on being released, frequently penetrate the substrate directly. If there is no direct penetration when they fall, or if they are left lying on the substrate by receding water, the seedlings are able to erect themselves after taking root. Although dependent upon the density of the water, the seedlings of *B. gymnorrhiza* and *R. mucronata* generally float more or less vertically, a feature which possibly aids their establishment when washed into herbaceous communities or when left amongst debris at high water level. *A. marina* seedlings which fall initially enclosed in the pericarp are also self-erectile after the roots have penetrated the substrate, but the distance that the plumule is lifted is very much less in *A. marina* than in the other two species, as mentioned in the Check-list. The initial rate of stem elongation is far more rapid in *A. marina* than in *B. gymnorrhiza* or in *R. mucronata*.

Since the propagules are water-distributed, mangroves will colonize any of the intertidal habitats to the uppermost limit of equinoctial tides, if other factors permit. One of the more important factors in regard to the successful establishment of seedlings is desiccation after the propagules have been left by receding water. Although no detailed experiments were carried out, field data suggest that *A. marina* seedlings, particularly after liberation from the pericarp, are the least tolerant of desiccation, also that the young roots are the most sensitive parts. It is suggested that the villi covering the radicle and those at the base of the epicotyl and first node of *A. marina* seedlings reduce the chance of desiccation by holding water during intertidal periods or whilst there is no precipitation.

Shade-tolerance of the three species varies. *A. marina* is the least shade tolerant, thus growth forms of individuals in a community serve as useful indicators of the ecological history of a particular habitat. Isolated specimens tend to have a spreading growth form often with few to several main stems arising from near the base; those that grow close together have an erect **form** with reduced lateral growth. The erect forms are typical of later establishment following initial colonization by a few trees. *B. gymnorrhiza* will grow in relatively deep shade, at least deeper than that able to be cast by *A. marina*, but seedlings are not able to develop satisfactorily under a well developed stand of their own species where light intensities are generally very low (see Table 3). More data are required in regard to shade-tolerance of *R. mucronata* seedlings: they undoubtedly develop far more satisfactorily where only lightly shaded, or not shaded at all; however, a few seedlings have been recorded from relatively deep shade, including, in one instance, shade beneath a stand of *B. gymnorrhiza* which was too dense for the establishment of its own seedlings.

The rate of growth of all three species is governed to a large degree by edaphic conditions. Although each species reacts differently to various edaphic factors, growth in general is more rapid where there is a reduction in high salinities, provided that adequate moisture is available. Because of this, variation in size of individuals or in composition of communities often bears more relation to edaphic conditions than to age. Frequently the individuals on a watercourse margin of a community are taller or more robust than those of equal age, or older, occurring further landward. Changes brought about by differential accretion subsequent to initial colonization contribute to the local variation.

A feature which is likely to be of advantage to mangroves is the coincidence of seedling release with the occurrence of the highest tides. *A. marina* exhibits this character very well since its main fruiting period, March and April, coincides with the autumnal equinox.

4.3.2.3.1.1 Pioneer mangrove communities

Depending upon edaphic conditions, all three species of mangrove are able to act as pioneers or as invaders of herbaceous communities within tidally affected parts.

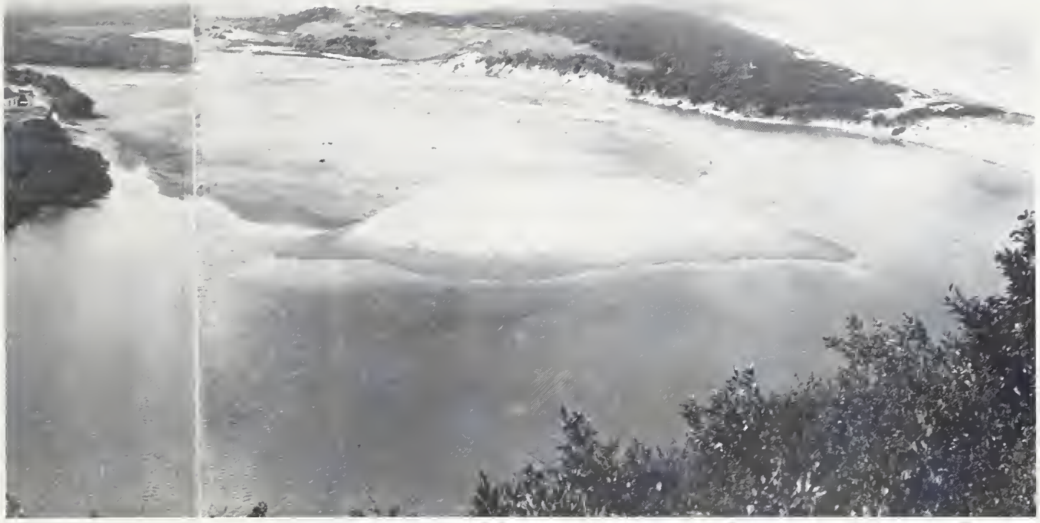
The most widespread and abundant pioneer mangrove is *A. marina*. Unless accretion has been so rapid as to permit initial colonization by herbs,

Fig. 46 - Changes in Sipingo Estuary, with particular reference to colonization and plant succession on alluvial spit deposited between Mlazi River (distant) and Sipingo River.

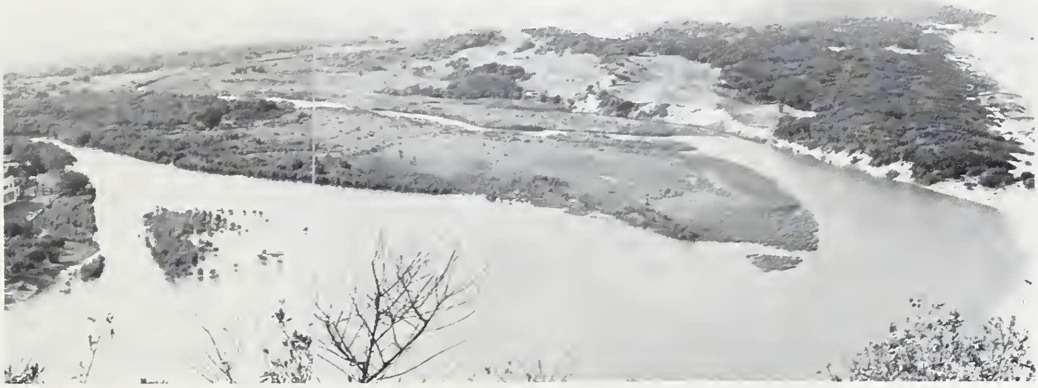
TOP PHOTO: Uncolonized low deltaic deposits more or less completely blocking Sipingo channel at low tide. At such times, Sipingo River flowed into lagoon, to left of photograph, via man-made boating canal prior to entering lower estuary in foreground. After boating canal blocked, Sipingo River flowed adjacent to front of hotel on left (channel shown by lack of colonizers in lower two photographs). After floods in 1935, Sipingo course more direct to sea.

MIDDLE PHOTO: Taken at high spring tide, shows early mangrove development: *Avicennia marina* pioneer communities in front of hotel and on Sipingo side of central spit; also in cut-off depression missing effect of main freshwater stream from Mlazi River (central middle distance). Extensive *Scirpus littoralis* Consocies along lowermost Mlazi River; halophilous grasses and forbs dominating lower parts of spit; psammophilous or hygrophilous grasses and shrubs above tidal level. See also Fig. 41.

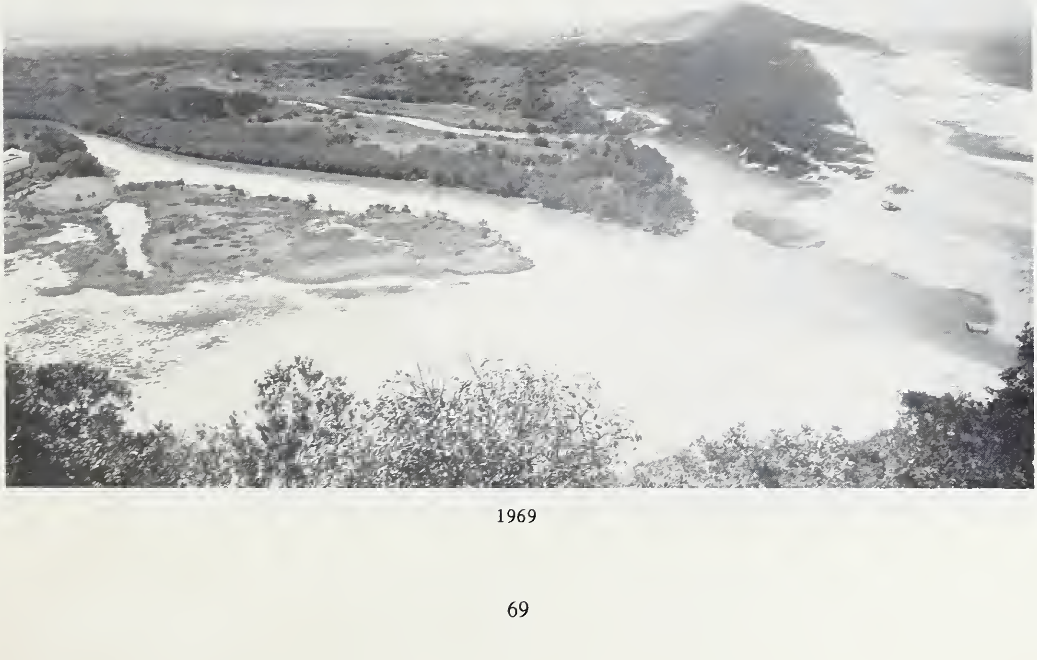
BOTTOM PHOTO: General growth of mangroves and their encroachment throughout, including into former Mlazi channel. (Mlazi River diverted 1952). Open patch near tip of spit: high ground colonized by *Stenotaphrum secundatum*, invaded by *Hibiscus tiliaceus* and few shade-tolerant mesophytic shrubs. (See also Fig. 40). Mangroves, on flats to left, cut at various times. *Phragmites australis* Consocies invaded by few *A. marina* in front of hotel. Sand introduced mainly by incoming tidal action (right foreground) and mainly by wind (right middle distance); latter colonized by *Sporobolus virginicus* Associes. Photo taken with outgoing spring tide showing pipes partially by-passed by currently open natural mouth



c. 1923 (copy from S.A.R. & H. photos)



1949 (Photos: A.W. Bayer)



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A. marina is generally the pioneer vascular plant on banks exposed at low tide. More permanent establishment takes place upwards from approximate high water neap tide (see Figs 41 and 46).

The density of the pioneer community varies, but it is not until conditions more favourable for seedling establishment are introduced that the denser pioneer communities are able to be developed. On low, freshly built-up banks, where deposited seedlings are liable to be moved by water prior to rooting and there is no protection from wind and sun, a pioneer community frequently consists of a few scattered shrubs of *A. marina*. These individuals produce radiating shallow roots from which the characteristic vertical pneumatophores later arise. Growth form varies with edaphic factors and the degree of competition for light, as already mentioned. Juvenile saplings are initially erect, but where not crowded they produce a branched bushy form. The height prior to branching is greater where salinities are relatively low and where there is an adequate supply of water, but not permanent inundation.

With the successful establishment of *A. marina*, especially after the pneumatophores have been produced, deposition of further material is encouraged. These later deposits are stabilized by the production of additional roots. Apart from branches of the larger horizontal roots, numerous slender branches are produced from the buried parts of the pneumatophores. With subsequent invasion of *A. marina* seedlings, the density of the community increases. This, together with general growth of the pioneers, leads to more shade being produced and, very importantly, a greater density of pneumatophores.

When the soil level is raised sufficiently, *Bruguiera gymnorrhiza* invades the *A. marina*

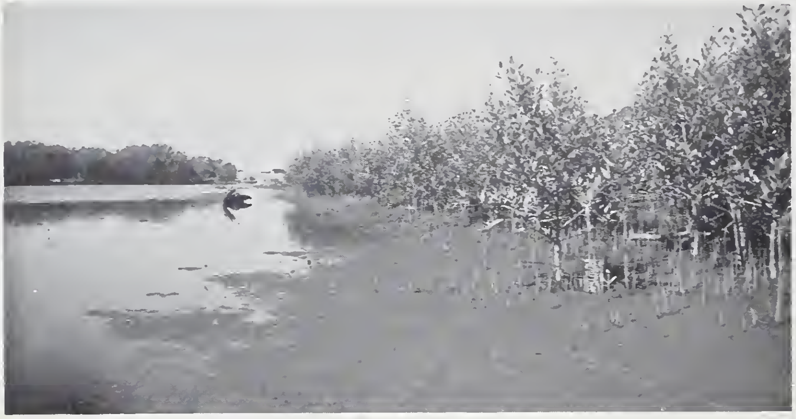

FIG. 47 - Pioneer *Avicennia marina* and one *Bruguiera gymnorrhiza* in sandy mud in lower estuary. Approx. 1-month-old juveniles with only 4-6 leaves in shallow water (established when water-level lower) and on bank. Older *A. marina* shrubs established on bank originally stabilized by earlier *A. marina*, periodically cut out. Pneumatophores in foreground extend to 2,18 m from base of sapling 1,22 m tall. Notebook 10 x 16 cm

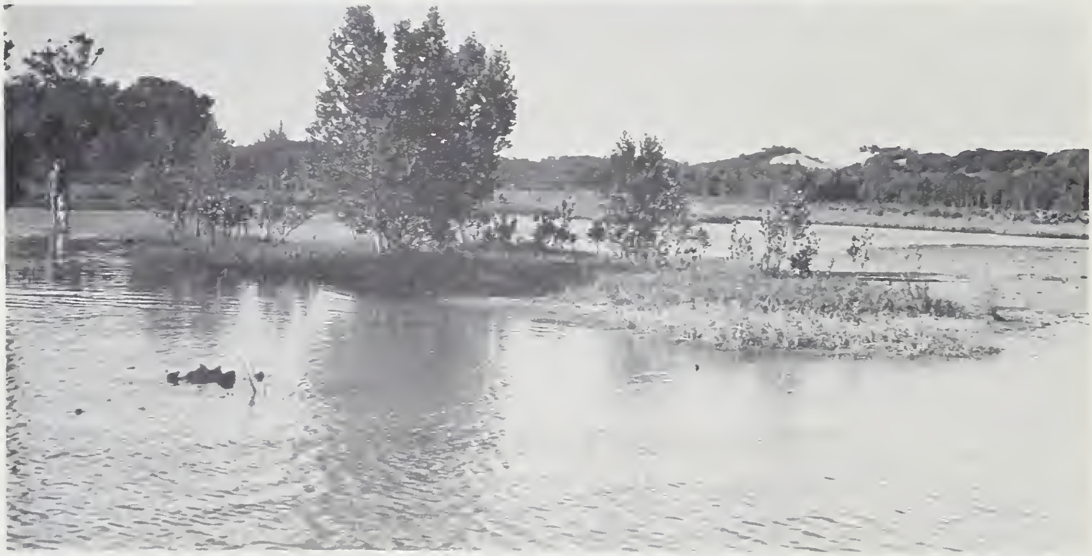

FIG. 48 - Soil accretion at base of pioneer *Avicennia marina* and subsequent colonization by other halophytes, near high water ordinary spring tide. Original pioneer now central robust shrub; smaller *A. marina* represent more recent establishment over several years, including juveniles approx. 8 months old. Other shrubs are *Bruguiera gymnorrhiza* of various ages. Herbs: *Arthrocnemum natalense* var. *natalense* in foreground, tufted *Juncus kraussii* and grasses, *Sporobolus virginicus* and *Paspalum vaginatum*

pioneer community, whether the canopy be open or closed. Depending upon the edaphic conditions and on the amount of shade produced, various halophilous herbs are also able to become established in the *A. marina* pioneer scrub (see Figs 47 and 48).

Where conditions within tidal range have permitted herbs to be the initial colonizers, *A. marina* and *B. gymnorrhiza* invade more or less contemporaneously. *A. marina* grows more rapidly than *B. gymnorrhiza*, particularly where there is frequent tidal inundation and adequate drainage. Thus, even though the two invade contemporaneously, *A. marina* assumes initial dominance (see Figs 41, 46 and 51).

On muddy soils towards the upper tidal limits, especially in places remote from the mouth, *B. gymnorrhiza* becomes progressively more important in pioneer mangrove communities invading herbaceous communities. This is particularly the case where there is a freshwater influence so that inundation is either infrequent or mainly by water of low salinity. In such situations *B. gymnorrhiza* grows rapidly and frequently forms pure communities. Sometimes these are secondary. On the banks of the estuary, only rarely does *B. gymnorrhiza* occur as a pioneer on fresh accretions unaccompanied by *A. marina*. Wherever the two become established together, *A. marina*, being the faster grower, assumes initial dominance in the early stages of succession.

Where there is a high water table, brought about by an impediment to drainage rather than by a low altitude, and standing water occurs frequently, *Rhizophora mucronata* acts as a pioneer. In the study area *R. mucronata* is mainly reliant on the prior colonization by other species. *R. mucronata* invades the outer fringe of the previously established mangroves mainly where accretion is very slow and is comprised of material of fine texture and where salinities are moderate to relatively high. In addition, young specimens become established amongst the lower outer pneumatophores of *A. marina*, or slightly beyond them if the water is not too deep and if the substrate does not dry out too much (see Fig. 49).

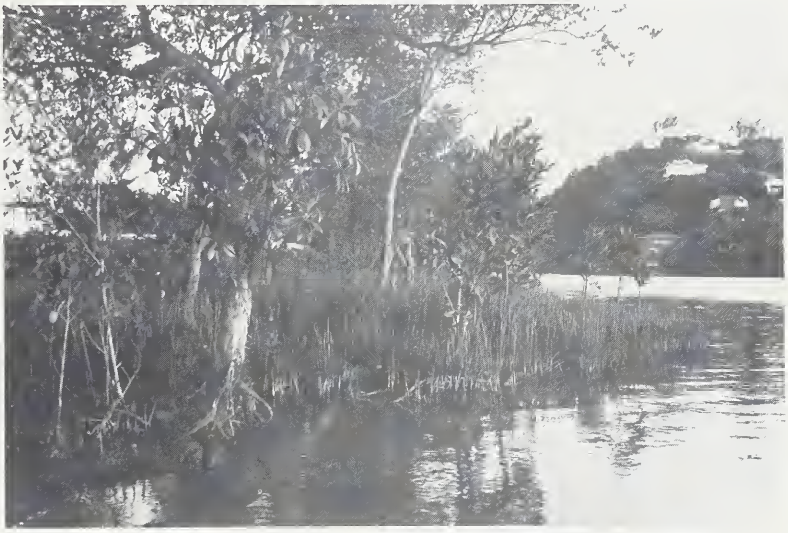

FIG. 49 - *Rhizophora mucronata* pioneers (one with seedlings) amongst *Avicennia marina* pneumatophores on bank of lagoon. Impeded drainage maintains relatively high water-level for prolonged periods. *Bruguiera gymnorrhiza* young tree, and juvenile immediately beneath it, above present water-level. Young *A. marina* amongst pneumatophores of older specimens on bank and just within water. Relict fringe of former dense mangrove woodland

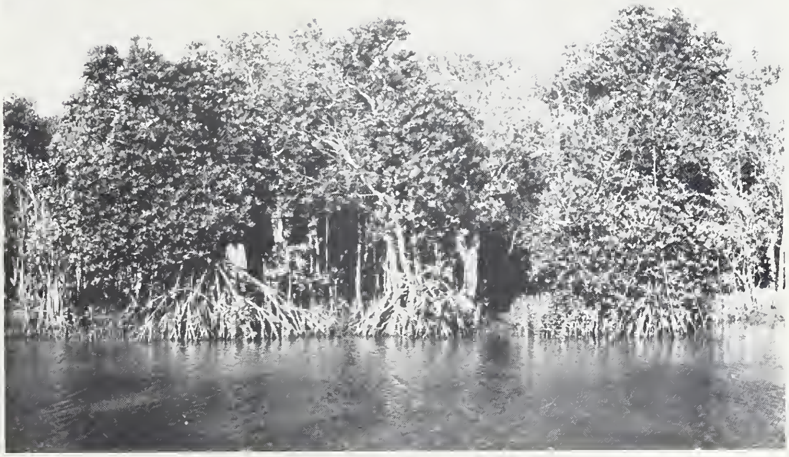

FIG. 50 - *Rhizophora mucronata* at margin of *Avicennia* Locies of *Avicennia-Bruguiera* Woodland on muddy bank of lagoon. Largest specimen on right 6,2 m tall, stilt root basal cover 4,2 m max. diameter, adventitious root facing camera 4 m long arising from branch 3,7 m above ground. Seedlings mostly in water, mouth blocked

With growth, these *R. mucronata* extend their stilt roots to a little beyond the former limit of the *A. marina* pneumatophores, thus facilitating accretion. Further accretion is encouraged when the *R. mucronata* trees drop seedlings into the mud, as is shown in Fig. 50.

In the study area *R. mucronata* is rather an invader of *Avicennia* or *Avicennia-Bruguiera* Communities, as discussed later. In only relatively limited places does *R. mucronata* occur as a pioneer in the manner described above. This is mainly on the shores of the blind lagoon where this community forms a discontinuous fringe. In more recent years it has become increasingly more abundant on the southern bank of the central section of the Sipingo estuary; no doubt aided by man's interference with the local drainage and supply systems.

4.3.2.3.1.2 Mangrove scrub and early woodland communities

With growth of the individual plants, the pioneer communities are eventually replaced by woodland communities. The rate of growth and change in composition depends to a large degree upon edaphic conditions and the initial structure of the pioneer community.

Where the canopy is discontinuous and soil levels are sufficiently high, halophilous herbs frequently occur in early mangrove communities, as already mentioned.

In *Avicennia marina* Scrub, following closure due to growth and further invasion, the shade becomes too great for further successful establishment of *A. marina* seedlings, other than at the margins. Any of the halophilous herbs which might have been present are shaded out. Weak basal branches of *A. marina* shrubs die so that a more erect growth form is produced. In addition, throughout this sere as the individuals grow taller there is a reduction in number.

Where conditions permit the continued growth of *A. marina* this remains the dominant in earlier woodland communities. The subordinates vary with edaphic conditions. Where there is active accretion the main subordinate is *Bruguiera gymnorrhiza*. This is tolerant of the shade cast by *A. marina*, and increases in abundance with less inundation. The growth rate of *B. gymnorrhiza* is particularly slow where there is frequent inundation by tidal water (see Fig. 51). The rate increases, however, where there is an increase in dilution of salt water, provided that any inundation is neither too deep nor too prolonged. As edaphic conditions improve for *B. gymnorrhiza*, invasion continues until the shade becomes too severe for the establishment of its own juveniles. Due to the more rapid growth of individuals under improved conditions, *B. gymnorrhiza* shrubs or young trees generally form a more or less continuous layer. This evenness of size and continuity of the stratum often occurs from the initial stages in places of relatively rapid accretion. Where there are gaps in this stratum sufficient sunlight is generally able to penetrate the taller *A. marina* canopy so as to permit growth of *A. marina* saplings. More generally, however, the only growth that takes place is limited initial growth from seedlings which later die.

Eventually *B. gymnorrhiza* trees form the upper canopy of a woodland which has taller *A. marina* trees occurring as discontinuous emergents. Later, *B. gymnorrhiza* replaces *A. marina*.

B. gymnorrhiza-dominated communities are frequently closed from initial establishment, thus preventing invasion by other halophytes. In time, such communities progress directly to mature *Bruguiera* Woodland in the upper intertidal reaches. The only significant changes are the loss of weaker individuals and an increase in height of the remainder.

Variations of this general pattern of succession occur where drainage systems are altered.

The level to which the substrate has been built up prior to the change in drainage pattern is very important. The rate of accretion is an important factor since it not only influences the level reached, but also the texture of the substrate and the earlier colonizers.

In a region of active accretion, as was described above, as early *A. marina* communities develop there is an increase in density of both individuals and, very importantly, pneumatophores. Deposition of water-borne material is encouraged at the outer fringe. The heavier material is deposited first. Thus accretion tends to be slower and of progressively finer material with increased distance from the transporting stream. Wind-blown material, generally readily available where there has been rapid accretion, is deposited in a similar manner.

This differential accretion leads to changes in soil texture, drainage patterns and to the frequency of tidal inundation. This, in turn, generally leads to changes in composition of earlier established communities further landward. Plants tolerant of poorly drained soils in which salinities are able to be built up, particularly in the dry season, become dominant. These changes also affect the development of the *A. marina* Community since the growth rate and invasion potential of *A. marina* is reduced.

Typically a less dense to open *A. marina* Scrub is produced on these soils which have impeded drainage and are infrequently inundated. *B. gymnorrhiza* is more tolerant of the reduced frequency of inundation, particularly by tidal water. Although slow-growing where salinities remain high, it becomes the dominant sooner than where *A.marina* is able to grow taller. Nevertheless, the shrub community may remain open for many years.

Owing to its open nature, several herbs occur in the field or ground layer of this scrub. The more common perennial herbs are *Juncus kraussii* and *Triglochin* spp. Both *T. bulbosa* and *T. striata* occur also in light shade. *Arthrocnemum natalense* var. *natalense* occurs marginally to this scrub or, where there is no shade, within it. Where accretion

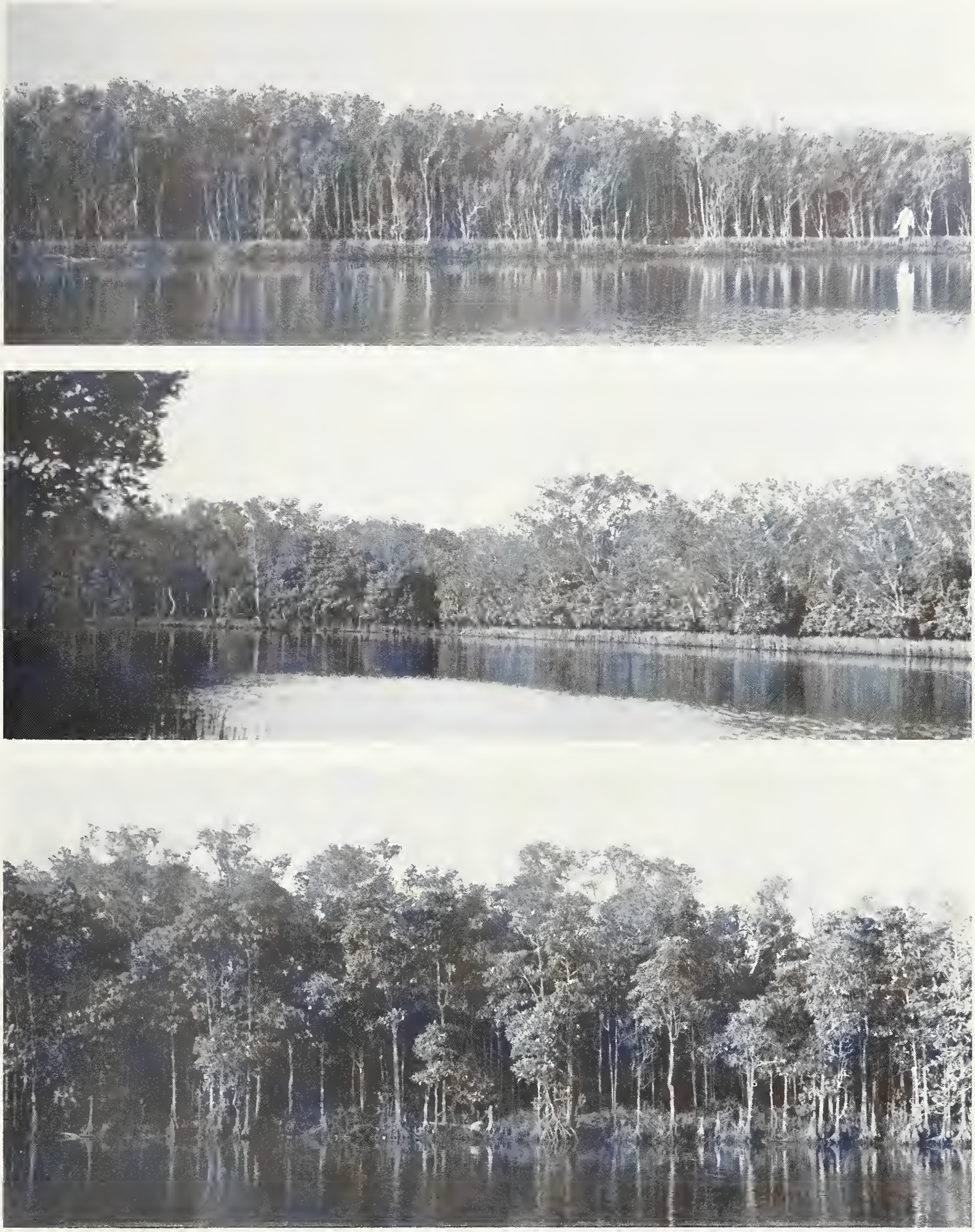

FIG. 51 - Stages in development of *Avicennia-Bruguiera* Woodland.

Top. *Avicennia* tall closed scrub towards estuary mouth (see Figs 41 and 46). Central shrubs up to 16 years old, approximately 5 m tall. *B. gymnorrhiza* invading, shrubs still short, especially near watercourse.

Central. To right of depression: *Avicennia* Woodland; taller *A. marina* c. 35 years old; *B. gymnorrhiza* taller further landward (not shown). To left: much older associes (see below), *B. gymnorrhiza* shorter near depression.

Bottom. Late *Avicennia-Bruguiera* Associes. Emergent *A. marina* up to c.11 m. *B. gymnorrhiza* continuous canopy, except where disturbed. *Rhizophora mucronata* subsequent establishment on steep bank above permanent water. *Atriplex patula* subsp. *verreauxii* and *Aster squamatus*, somewhat etiolated, forming ephemeral (summer) community on raised mud where canopy disturbed. Note increased incutting where density of *A. marina* pneumatophores reduced. Growth-forms more spreading where competition less and more light available has been sufficient, *Stenotaphrum secundatum* or *Hibiscus tiliaceus* are able to become established in this scrub. Further deposition of material from flooding rivers has sometimes occurred on these raised parts, thus permitting subsequent invasion by mesophytic members of the low-lying scrub or woodland communities.

In lower-lying parts where an impediment prevents maximum drainage and allows water to stand for long periods, *Rhizophora mucronata* becomes increasingly more important. In addition to the already mentioned discontinuous narrow fringe of pioneer *R. mucronata*, this species has invaded *Avicennia* or *Avicennia-Bruguiera* Communities where a change in the drainage system has caused prolonged submergence. This invasion has been mainly at the expense of previously established *B. gymnorrhiza* which is less tolerant of prolonged inundation than *A. marina*.

The presence and increase in numbers of individuals of *R. mucronata* over the past two decades or so are regarded as being indicative of a potential succession to a community in which *R. mucronata* eventually becomes the dominant. It is suggested that this will take place only where accretion is extremely slow and where drainage is impeded. Such pure communities did not exist in the study area although there were small local aggregations of these trees with their stilt roots forming dense tangles. These have been eliminated by recent infilling activities. Currently *R. mucronata* occurs mixed with *B. gymnorrhiza* and *A. marina* in closed scrub and woodland communities, mostly in fine mud and where water is plentiful and of moderate salinity. It is better developed where sunlight penetration is not unduly restricted.

4.3.2.3.1.3 Mature mangrove communities

With continuous, but not unduly rapid, accretion the last stage in primary mangrove succession is tall closed *Bruguiera gymnorrhiza* Woodland. By the time that this has developed, soil levels have been raised by deposition of water-borne material, mostly of fine texture, and by the action of crabs. Water-borne organic debris and falling leaves contribute to the organic enrichment of the substrate, also aided by the action of crabs. The shade produced is generally too great for other halophytes or for the satisfactory establishment of additional seedlings of *B. gymnorrhiza*, unless there is disturbance. In one part only of the study area a few clumps of *Acrostichum aureum* occurred as a scattered field layer beneath *B. gymnorrhiza*. This was where shade was not as intense as had been observed elsewhere and water from a nearby freshwater swamp originally drained through the community.

The only other vascular plants associated with mature *B. gymnorrhiza* Communities that were recorded were two epiphytes: *Cyrtorchis arcuata* and, along the banks of the Sipingo River, *Ficus natalensis*. The latter was not able to develop beyond the epiphytic stage and remained small until destroyed in recent years.

Since *B. gymnorrhiza* is able to continue living after soil levels have been raised above the reach of maximum tides, with an increase in soil level succession passes directly into low-lying early forest communities. Under such circumstances the shade produced is sometimes too great to permit the establishment of *Hibiscus tiliaceus*. More generally, however, *H. tiliaceus* becomes the dominant in a zone transitional to mesophytic forest, or, at least, indicative of the uppermost tidal limit.

In regions of rapid accretion, invasion by *H. tiliaceus* or members of later communities takes place in any of the mangrove communities as long as the soil levels are raised above tidal reach.

4.3.2.3.2 *Hibiscus tiliaceus* Communities

Hibiscus tiliaceus generally becomes established upwards from a little above high water ordinary spring tide in non-shaded or only very lightly shaded situations. It is better developed where salinities are minimal, but it will tolerate occasional inundation. In growth form it varies from a low spreading shrub to an upright tree.

Growth rate is slow in poorly drained brack soils where it forms a low open scrub (see Fig. 44). In such situations its establishment appears to be aided by the burrowing activities of crabs. In the slightly higher, better drained soils where freshwater is adequate, it is much faster growing and, while it eventually assumes a tree form, it is generally rambling at first. These spreading trees eventually merge to form a closed ecotone between true halophytes and the mesophytic communities. Where accretion is sufficient, and other factors permit, *H. tiliaceus* is invaded by forest species. As these other trees increase in size they eventually oust *H. tiliaceus*. The *H. tiliaceus* zone becomes restricted to an extremely narrow fringe where shade-producing mangroves have become established on the lower side and forest or woodland on the upper side.

4.3.3 Community interrelations

Suggested interrelations of the various estuarine communities have been discussed throughout Section 4.3 and, in a much simplified manner, are illustrated in Fig. 52.

Owing to the considerable fluctuations in the environmental conditions, the successional relations tend to be complex. Throughout the whole sere there is marked edaphic control with particular regard to inundation by salt water and drainage. The natural succession, however, has been disturbed by the direct action of man or indirectly by man's interference with the drainage and supply systems.

The rate of accretion is undoubtedly of paramount importance. This has not only governed the height to which deposits have been built, thereby affecting the salt:freshwater ratio, but also has affected the texture of the deposited material.

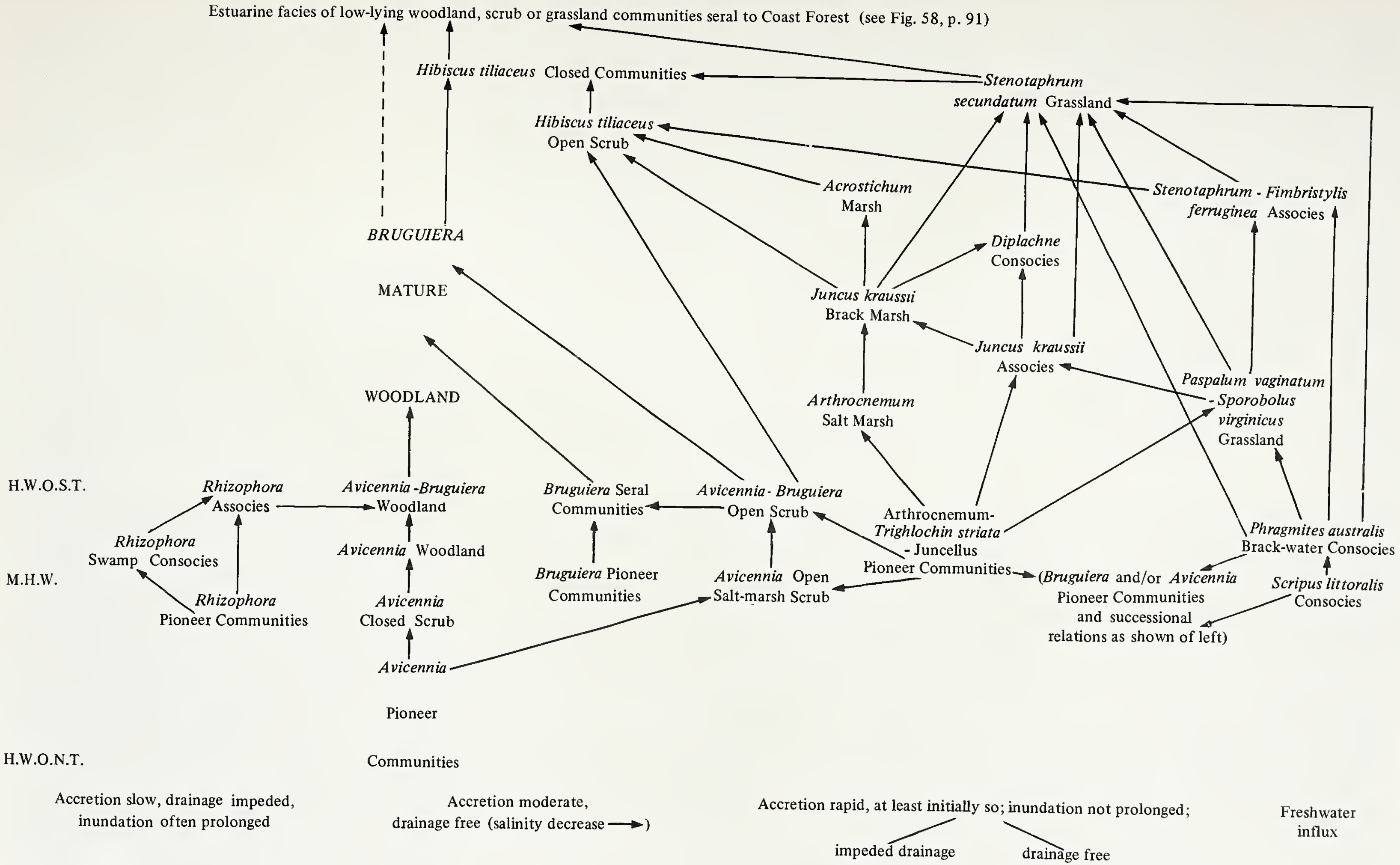
Estuarine facies of low-lying woodland, scrub or grassland communities seral to Coast Forest (see Fig. 58, p. 91)
Hibiscus tiliaceus Closed Communities
Stenotaphrum secundatum Grassland
Hibiscus tiliaceus Open Scrub
Acrostichum Marsh
Stenotaphrum - Fimbristylis ferruginea Associes
BRUGUIERA
MATURE
WOODLAND
Diplachne Consocies
Juncus kraussii Brack Marsh
Juncus kraussii Associes
Paspalum vaginatum - Sporobolus virginicus Grassland
Arthrocnemum Salt Marsh
H.W.O.S.T.
Rhizophora Associes
Avicennia -Bruguiera Woodland
Bruguiera Seral Communities
Avicennia - Bruguiera Open Scrub
Arthrocnemum- Trighlochin striata - Juncellus Pioneer Communities
Phragmites australis Brack-water Consocies
Rhizophora Swamp Consocies
Avicennia Woodland
M.H.W.
Rhizophora Pioneer Communities
Bruguiera Pioneer Communities
Avicennia Open Salt-marsh Scrub
(Bruguiera and/or Avicennia Pioneer Communities and successional relations as shown of left)
Scripus littoralis Consocies
Avicennia Closed Scrub
Avicennia
Pioneer
H.W.O.N.T.
Communities
Accretion slow, drainage impeded, inundation often prolonged
Accretion moderate, drainage free (salinity decrease →)
Accretion rapid, at least initially so; inundation not prolonged;
impeded drainage
drainage free
Freshwater influx

FIG. 52 - Generalized suggested interrelations of estuarine vascular plant communties at Isipingo. Scheme very much simplified, see text for further details regarding local variations in community composition and environmental factors. *Zostera capensis* submerged consocies omitted. Levels only approximate : H.W.O.S.T. = High Water Ordinary Spring Tide; M.H.W. = Mean High Water; H.W.O.N.T. = High Water Ordinary Neap Tides

Where accretion has been most rapid, that is, in the vicinity of the former main feeder stream, the Mlazi, the deposits contain a greater percentage of coarse sand. Deposits further away are of finer material with an increasing proportion of clay, particularly in saline or brack distant back-waters.

The combination of the two rivers, the Sipingo and the Mlazi, have produced a set of environmental conditions which has led to the development of a wide variety of estuarine communities. Prior to its diversion, the Mlazi River contributed a considerable amount of freshwater which, until restricted by dam-construction and aggravated by droughts, was sufficient for maintaining a virtually permanently open mouth. This is a fundamental necessity for the successful establishment and healthy spread of mangroves. However, in addition to supplying freshwater, the Mlazi also injected a considerable quantity of alluvium into the estuary at a rate more suitable for colonization by hygrophilous or psammophilous herbs than for the establishment of mangroves. The drowned Sipingo River and Lagoon, on the other hand, provided an ideal habitat for the development of mangroves, having the advantage of an open mouth and the free movement of tidal water for considerable distances from the mouth. The increase in the clay content of the substrate no doubt aids water retention when water-levels are low, an advantage, within limits, to mangroves.

Under these circumstances, with a relatively slow rate of accretion at least after elevation had reached approximately high water ordinary neap tides, mangroves became the dominant vegetation type. With a free interchange of waters and becoming progressively less saline with a rise in elevation, *Avicennia marina* is the pioneer eventually giving way to *Bruguiera gymnorrhiza* in a deeply umbrageous woodland. As long as the elevation of the substrate is such that tidal waters can over-flood, succession is unable to proceed to the more mesophytic communities. Where accretion is sufficient to prevent inundation by tidal or brackish water, succession passes to low-lying forest communities. Where conditions are sufficiently open, *Hibiscus tiliaceus* (a semi-mangrove, *sensu* Richards, 1952) becomes the dominant in an ecotone between true halophytes and the low-lying mesophytes.

The numbers and distribution pattern of *Rhizophora mucronata* suggests that this has been the last mangrove to have become established in the Sipingo estuary. This invasion occurred, however, well before this investigation. In the earlier times whilst there was free drainage at low tide and limited or no prolonged submergence, *R. mucronata* played a minor role in mangrove succession. With siltation in the lower estuary, accelerated by present-day frequent and prolonged closure of the natural mouth, full drainage at low tide has been very much reduced or, for long periods, prevented. This has increased the level of brackish waters, reduced the flow rate and, until the mouth was piped, led to prolonged submergence. These conditions have favoured the spread of *R. mucronata* in those parts not in the immediate vicinity of the mouth nor where salinities are consistently very low.

4.4 HYDROSERE

Soils on which hydroseral communities occur vary in the study area. Coarse sandy alluvium is most plentiful in the vicinity of the Mbokodweni River and the more modern courses of the now-diverted Mlazi River. Elsewhere the deposits have a much higher percentage of finer sand, silt or clay. In low-lying parts with impeded drainage the substrate that develops under aquatic or semi-aquatic communities is frequently peat-like. The significance of the texture of the substrate lies in its aeration, water-holding capacity and stability under the action of wind or water, all of which influence plant colonization and succession.

In the vicinity of any of the transporting streams the same basic pattern of particle size sorting occurs. In addition, the bulk of the transported material is deposited on the immediate banks of the stream. Finer particles mixed with these deposits are later washed downwards by rain action, thus these higher deposits become increasingly more sandy. These exposed washed sands dry readily and, depending upon the amount of colonization by plants, are liable to be driven further by wind. Clayey soils have a better water-holding capacity and are more stable when exposed.

Deposition of material by floods leads to changes in edaphic conditions and to existing vegetation. On the raised parts, drainage is improved and succession is able to proceed towards more advanced mesophytic communities. On the other hand, drainage from beyond the deposition is generally impeded. This leads to local deposition of finer material where silt-laden waters remain for longer periods, thus accentuating the differences in edaphic conditions on the two sides of the deposition. Furthermore, the impeded drainage frequently results in hydroseral retrogression or deflection of subsequent succession on the further side.

In addition to these changes brought about by differential deposition of alluvial material, there has been considerable disturbance by man to various communities representing all stages in the hydrosere and to their habitats. This has been due to cutting, burning, draining and, most severe of all, infilling.

Within the study area the only open freshwater that occurs today, apart from temporary rain-filled depressions where drainage is inadequate, is that in the Mbokodweni River, the upper reaches of the Sipingo River and the drains flowing into this river or into the sea at Reunion Rocks.

The Mbokodweni River is the strongest and carries the greatest silt-load. Its volume and silt-load, however, vary considerably, depending upon the amount of rain in its catchment area (see Fig. 1). In the dry season it is mostly an almost clear small stream steadily flowing over a sandy substrate. Its mouth, however, blocks frequently, thus it is only above the level of the impounded waters that there is a constant flow-rate. Furthermore, the impounded water is generally lightly brackish.

The other water courses mentioned are also perennial, but they are much smaller and have muddy beds. Although they are directly affected by local rains, their flow-rate is mostly lower and water is more constantly available for plant growth. They also carry a much lower silt-load which varies, depending upon local disturbance, and is chiefly of very fine material. The last mentioned, which drains relic reedswamps mainly from beyond the limits of the study area, has little or no silt-load and traverses organically enriched deposits.

4.4.1 Pioneer and early herbaceous communities

From the point of view of hydrophytes, the environmental conditions associated with the more strongly flowing, but erratic, main rivers (now only the Mbokodweni) contrast markedly with the less severe conditions of the smaller streams, drains or water-filled depressions. This is reflected in the plant communities which are treated here under two separate sections.

4.4.1.1 COMMUNITIES IN SMALL STREAMS AND DEPRESSIONS

4.4.1.1.1 Submerged hydrophytes

Where the flow-rate is not severe and the silt-load is not excessive, submerged aquatics form the pioneer communities.

In rain-filled depressions the water is often of such short duration that the only aquatic plant communities that are able to become established are those of various small algae. Where water retention is of longer duration, or relatively slowly flowing water is available for longer periods, larger algae and submerged vascular plants are able to become established.

Non-anchored filamentous Chlorophyta, particularly *Spirogyra* spp., are dominant in the early stages of this succession. Commonly occurring a little later is *Nitella* sp.; this anchored alga is the largest of the local freshwater algae.

Vascular submerged plants include *Ceratophyllum demersum* which is common early in succession where the flow-rate is light to moderate. It occurs also in standing water, but this would appear to be where drainage has been impeded (see Figs 53 and 54). Rhizomatous *Potamogeton crispus* and *P. pusillus* occur where the water is flowing, even if this is sluggish. Of these, *P. crispus* is the more common in the study area.

These submerged hydrophytes often occur in abundance and severely interfere with the flow-rate of the stream. Deposition of water-borne material is facilitated, not only by the reduction in flow-rate, but also by the surface area offered by these plants. *C. demersum*, in particular, has a large surface area relative to bulk and epiphytic algae, bacteria and very small particles of organic debris generally cover the greater part of the plant body, particularly the older parts.

4.4.1.1.2 Floating hydrophytes

Following the submerged hydrophytes are various floating hydrophytes (see Figs 53 and 54). Flow-rate is again an important factor, but silt-load or turbidity which affect the submerged aquatics, are not directly important to this group.

Where water is not flowing, or is only slightly flowing, *Nymphaea capensis* is among the earlier invaders (see Fig. 53). In many cases its early appearance in open water in seasonal ponds is due to earlier establishment of its perennial rhizomes. These are able to remain dormant in moist muddy soils and produce the characteristic floating leaves when the water cover is sufficient.

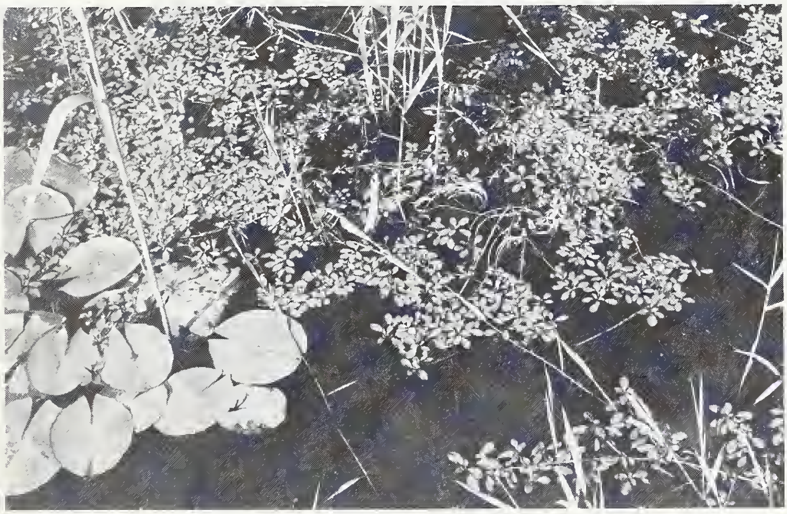

FIG. 53 - Pioneer communities in seasonal standing freshwater. Submerged: *Spirogyra* sp. (right middle distance) and more abundant *Ceratophyllum demersum.* Floating: *Nymphaea capensis* (large leaves) and *Ludwigia stolonifera,* with white pneumatophores. Emergent: *Leersia hexandra* (slender trailing stems) and erect *Phragmites australis*

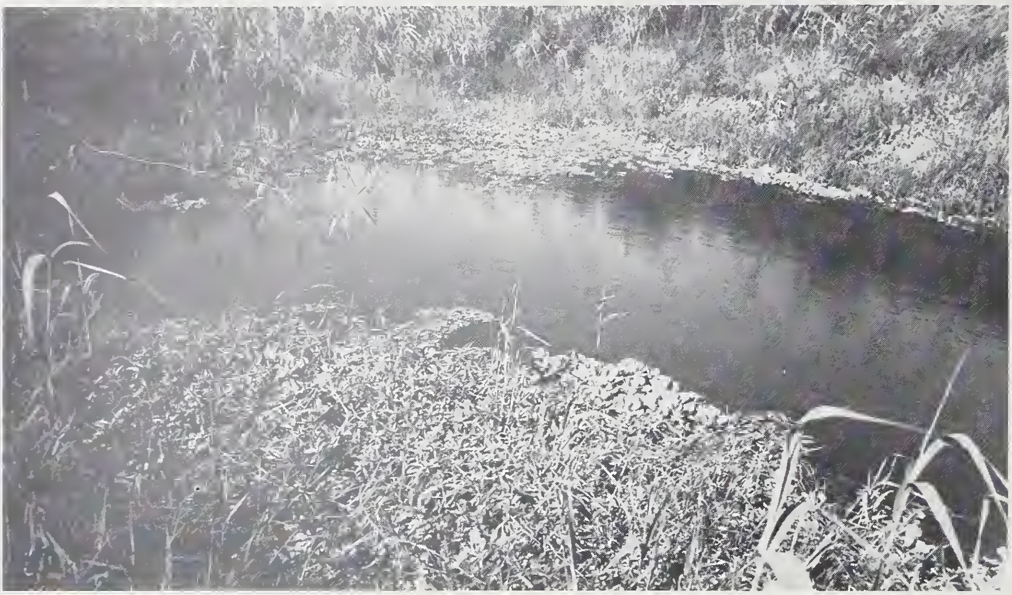

FIG. 54 - Seral communities in perennial moving water. Drain periodically cleared. Succession to *Phragmites australis* reedswamp in background where not recently disturbed. *Leersia hexandra* and *P. australis* extending into and beyond raft of *Ludwigia stolonifera, Salvinia molesta, Lemna* sp., *Wolffia arrhiza* and *Pistia stratiotes.* Surface reflection masks submerged communities, *Ceratophyllum demersum* dominant, especially in distant less disturbed part where not shaded by floating aquatics. *Pycreus mundtii* at base of far bank, centre and to right, extending onto floating aquatics

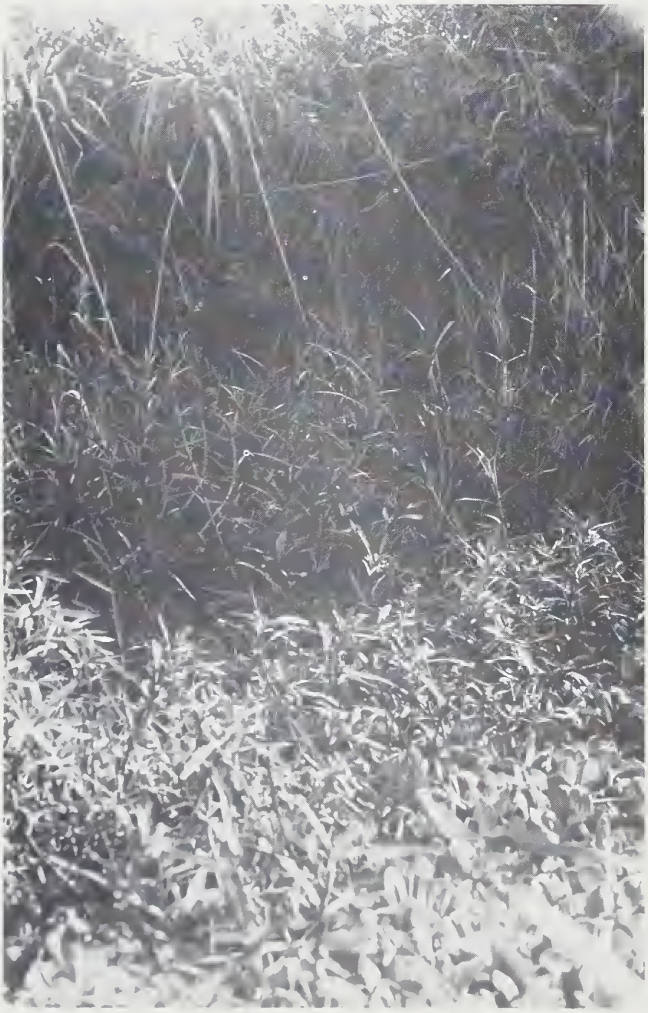

FIG. 55 - Mature floating aquatic community immediately prior to invasion by reedswamp. *Pistia stratiotes,* abundant, supporting and being shaded out by fertile ascending branches of *Ludwigia stolonifera* (left foreground to middle distance). This in turn shaded out by more robust *Pycreus mundtii. Phragmites australis* in background, mostly on bank. *Ipomoea congesta* twining around *P. australis.* (Photo: B. Cuffley)

Several non-anchored floating aquatics occur in the study area. These include *Eichhornia crassipes* which is more abundant where there is no or very little flow. It sometimes occurs rooted in water-logged soils or, at least, it remains alive for longer periods than the other free-floating hydrophytes when left on moist land by receding water.

Other floating aquatics include *Wolffia arrhiza, Lemna gibba, L. minor* and the more robust *Pistia stratiotes.* Whilst these occur where the water is still or almost so, they also occur where there is a moderate flow-rate of the stream. In the latter case, whilst the water itself may be moving, these hydrophytes are frequently held by some obstacle. In recent years *Salvinia molesta* has become abundant in the perennial drains of the north-eastern extremity of the study area. A floating hepatic, *Ricciocarpos natans*, occurred in this vicinity until the early 1950's.

These floating hydrophytes eventually cover the surface of the water, very rapidly under ideal circumstances, and shade out the submerged hydrophytes. A dense raft of floating aquatics facilitates invasion by stoloniferous or rhizomatous plants which would otherwise be limited to shallower water or the banks. As these hydrophytes die so they contribute to the organic enrichment of the substrate. They add to material accreting not only beneath the water, but also on the banks when free-floating hydrophytes are left, often in considerable quantity, by receding water.

4.4.1.1.3 Semi-floating hydrophytes

Following communities of the above two groups of aquatics and preceding the more robust anchored emergent hydrophytes are such species as *Ludwigia stolonifera, Leersia hexandra* and *Pycreus mundtii.*

Of these, *L. stolonifera*, in particular, behaves in a similar way to a true floating aquatic (see Figs 53 and 54). Although initially rooted in moist soil, this either grows out over open relatively deep water or, when shallowly submerged, produces floating stems which radiate over the surface of the water. The airspace system in the stems keeps them buoyant, although the aerenchymatous adventitious roots which are produced under aquatic conditions no doubt aid in this function as well as acting as pneumatophores. When the community becomes denser, upright flowering branches are produced (see Fig. 55). Whilst colonization by true floating hydrophytes aids the development of *L. stolonifera*, it is not dependent upon them for its spread across the surface of the water.

Leersia hexandra, a rhizomatous grass, is generally rooted in moist soil on stream banks, but tolerates shallow permanent inundation. It also spreads into deeper water by means of trailing stems supported by floating hydrophytes (see Figs 53, 54 and 55).

Pycreus mundtii behaves similarly to *L. hexandra* (see Figs 54 and 55). Where water is abundant it follows *L. hexandra* in succession, generally shading out both it and the earlier mentioned hydrophytes.

4.4.1.1.4 Emergent anchored hydrophytes

In addition to the common *Leersia hexandra* and *Pycreus mundtii*, mentioned above because of their ability to invade water deeper than their own height, there are a number of other plants which are tolerant of basal inundation as well as prolonged emergence under moist conditions. These invade the communities of smaller plants when the water level is shallow enough. Their occurrence varies with different environmental conditions. Although edaphic factors play a major role in their ability to become established initially, they are mostly markedly heliophilous. Thus shorter members often occur at the landward margin of communities of taller plants although they are tolerant of deeper water than would be indicated.

The more widespread of the taller emergent hydrophytes are *Phragmites australis* (see Figs 53, 54 and 55), *Typha latifolia* subsp. *capensis, Cyperus latifolius* and, in shallower water or where less frequently basally submerged, *C. immensus. C. fastigiatus* is relatively uncommon in the study area, and appears to be more tolerant of basal submergence than *C. immensus.*

In the study area, *P. australis* is the most abundant of these. It becomes the dominant in the later stages of the aquatic phase of the hydrosere in much of the area. Where accretion is slow it extends into water deeper than the other listed plants, but where water is shallow, *T. latifolia* subsp. *capensis* frequently precedes *P. australis* in this succession.

Depending upon edaphic conditions, succession passes to different communities. Essentially the major differences appear to lie in drainage of the substrate. Where this is impeded and the water-table is high, reedswamp develops. Where drainage is free and the water-table is lower, various streambank communities are able to become established:

4.4.1.2 COMMUNITIES IN MAIN RIVER COURSES

The flow-rate and fluctuation of water-level are too great for the successful establishment of floating hydrophytes and submerged vascular plants. Microscopic algae, mainly Cyanophyta in the Mbokodweni River, are the only submerged plants.

The low-water channels in the sandy beds of the rivers vary in position, a factor which is adverse to the establishment of perennial anchored emergent hydrophytes. Where the channels are relatively permanent, *Eleocharis limosa* and, more commonly, *Cyperus articulatus* or *Typha latifolia* subsp. *capensis* occur as emergents in shallow water on sandy substrates. *E. limosa* and *T. latifolia* subsp. *capensis* occur also where the clay content is higher. These plants, particularly *C. articulatus*, facilitate accretion and stabilize the deposits, paving the way for colonization by streambank communities.

Pycreus mundtii, not as robust as the above mentioned, occurs very commonly early in the succession, frequently as a pioneer, at the lower parts of the permanent banks. It also extends into shallow water, rooted or semi-floating. Less frequent in the shallow water covering sandy substrates are *Ludwigia stolonifera, Leersia hexandra, Juncus lomatophyllus, Matricaria nigellifolia* var. *nigellifolia* and *Rumex nepalensis.*

Along the Mbokodweni River, *Rorippa nasturtium-aquaticum* occurs occasionally in shallow water where protected from the main current. In similar situations or where more exposed, but still moist, the taller *Ludwigia octovalvis* subsp. *sessiliflora* occurs frequently.

On the low alluvial deposits exposed by low river levels various plants are able to become established. These include microscopic algae and hygrophilous herbs. These pioneer communities are generally short-lived, being cleared by the force of water when levels rise again. Similarly, the less robust anchored emergents or semi-floating forms are cleared back to the more permanent main banks of the rivers. These are generally well stabilized by various streambank communities in which *Phragmites mauritianus* becomes one of the more important members (see Fig. 56).

The components of the pioneer communities on the exposed low-level banks vary with differences in edaphic conditions in which the amount of silt deposited on the sand and the height of the water-table are the more important. In moist sand the more common earlier members include *Scirpus prolifer, S. cernuus, S. chlorostachyus, Ilysanthes dubia, Pycreus flavescens* and the already mentioned *Pycreus mundtii* and *Ludwigia stolonifera.*

Others include:

Aster squamatus
Commelina diffusa
Cyperus compressus
C. difformis
Eclipta prostrata
Fimbristylis dichotoma
Juncus dregeanus
J. oxycarpus subsp. *australis*
Lobelia anceps
Mariscus congestus
Pentodon pentander
Polygonum glutinosum var. *capense*
P. pulchrum
P. salicifolium
P. sp. cf. *P. salicifolium*
P. senegalense forma *albotomentosa* (generally higher)
Pycreus polystachyos
Ranunculus multifidus
Spilanthes mauritiana

Of these, the *Polygonum* spp. become the more robust. Of the *Polygonum* spp., *P. salicifolium* and *P.* sp. cf. *P. salicifolium* are the more common, occurring also earlier than the others.

Grasses are not well represented in the more hygrophilous open pioneer communities. Those that occur include *Panicum subalbidum, Polypogon monspeliensis* and becoming important at slightly higher levels, *Hemarthria altissima. Agrostis*

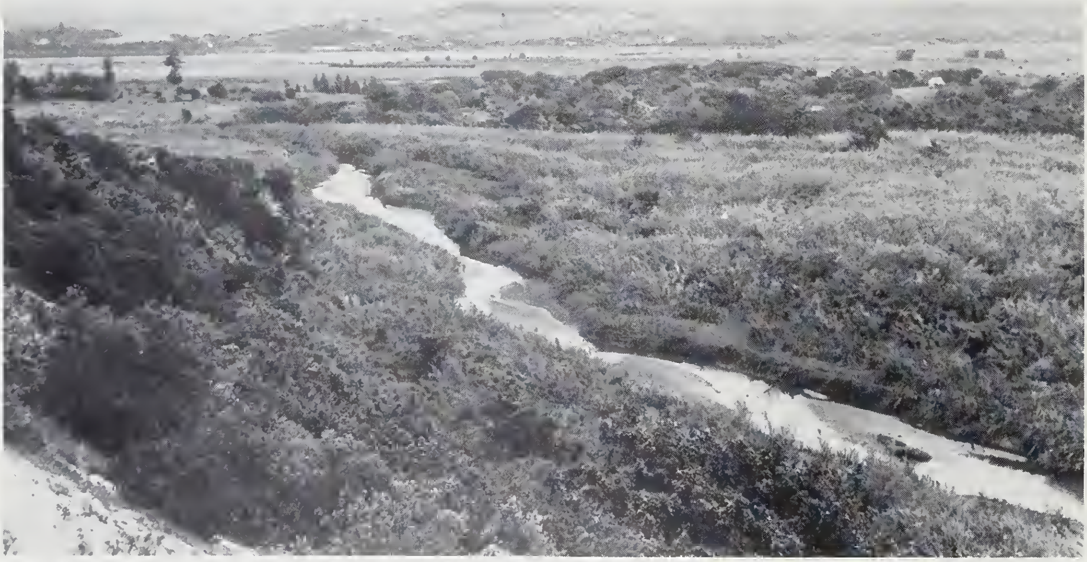

FIG. 56 - General view of riverain communities. Stream too erratic and with too heavy a sediment load for more highly modified hydrophytes. Erect leafless emergent *Cyperus articulatus* adjacent distant right bank, left centre. Steep main banks stabilized by *Pycreus mundtii*, near base where not shaded, *Leersia hexandra, Paspalum paspalodes* and large-leaved *Cyperus immensus. Phragmites mauritianus* dominant over most of flood-plain and on streambank. *Bridelia micrantha* and *Phoenix reclinata* invading *P. mauritianus* Consocies on flood-plain. *P. australis* dominant in depressions, particularly between tall distant *Phoenix reclinata* and far distant disturbed woodland - early forest communities, on right

lachnantha occurs occasionally, generally in earlier open communities.

Where the water-table is slightly lower, the surface soils become drier, particularly if these are sands, and several other plants are able to become established. The earlier ones in open sandy parts include *Corrigiola littoralis* subsp. *littoralis* var. *littoralis, Gnaphalium declinatum, G. luteo-album, G. pensylvanicum* and several other forbs, grasses and a few Cyperaceae which are dealt with later under streambank communities or later hydroseral communities.

4.4.2 Reedswamp communities

Where drainage is impeded and water often stands for long periods, or it flows very sluggishly, reedswamp communities are able to become established. As mentioned already and as shown in Figs 54 and 55, these communities represent a later stage in the hydrosere, generally following directly the earlier described pioneer communities, when the substrate has been built up sufficiently. Reedswamp communities also invade or replace less hygrophilous communites where an impediment to drainage causes a very high water table to develop, particularly where water covers the surface for prolonged periods.

Although *Typha latifolia* subsp. *capensis* is locally dominant in a few limited places, the most important member of the reedswamp communities in the study area is *Phragmites australis. P. australis* varies in height up to 4,5 m. In the lower parts it more generally forms dense pure stands. Where submergence becomes progressively less, several other anchored emergent hydrophytes are able to become established with *P. australis*. Since the majority of these are not shade-tolerant they occur at the margins of the *P. australis* Consocies, unless the *P. australis* cover has been reduced.

Edaphic conditions govern the composition of the marginal communities. Where the gradient is very slight, the water-table high and the soil organically enriched, the best development of hygrophilous marginal plant communities occurs. Where the gradient is steeper, the soils are generally sandier and better drained; the marginal communities are consequently less hygrophilous. Scandent forms, however, are able to extend into reedswamp, often as important constituents of the canopy, even though they are rooted on more distant better drained soils.

The more robust or taller of the hygrophilous marginal plants are *Typha latifolia* subsp. *capensis, Cyperus latifolius, C. immensus, C. fastigiatus, Hibiscus diversifolius* and, periodically, *Echinochloa crus-pavonis*. Of these, the first three are the more common. Other less robust, but also common, species include: *Ludwigia octovalvis* subsp. *sessiliflora, Polygonum pulchrum, P. salicifolium, Thelypteris totta* and *Zantedeschia aethiopica*. *T. totta* frequently is dominant in a zone marginal to *P. australis* reedswamp. *Laportea peduncularis* also occurs with these marginal plants, generally not in water unless this is a temporary condition. *L. peduncularis* is the most shade-tolerant of the above list. *Leersia hexandra* commonly occurs in these marginal communities where sunlight is adequate.

Other marginal plants include *Cyperus prolifer* and *Gunnera perpensa*, neither of which were common in the study area and have not been recorded in recent years. On the central and southern sections of the Isipingo Flats, *Canna indica* occurred occasionally, sometimes locally frequently, in the marginal communities.

Where edaphic conditions remain moist, these taller hygrophilous communities grade into shorter communities. These latter communities occur on soils that are more or less permanently moist, but are not as subject to prolonged inundation as are the reedswamp communities. These are rather marsh communities which, in the study area, are confluent with the reedswamp communities. They are treated here, therefore, as extensions of the hygrophilous marginal communities rather than as a separate section. These communities, and the taller marginal communities, have been much reduced in man's quest for more land for sugar-cane.

These shorter hygrophilous plants include:

Acroceras macrum
Brachiaria arrecta
Carex cognata
Commelina diffusa
Eclipta prostrata (open)
Eleocharis limosa
Fimbristylis complanata
Geranium ornithopodum
Hydrocotyle bonariensis
H. verticillata
Juncus dregeanus
J. lomatophyllus
Kyllinga elatior
K. nemoralis
Lobelia anceps
L. erinus
Monopsis stellarioides
Panicum hymeniochilum var. *glandulosum*
Paspalum paspalodes (disturbed)
Pentodon pentander
Plantago major (disturbed)
Polypogon monspeliensis (disturbed)
Pycreus flavescens
Ranunculus multifidus
Samolus valerandi
Scirpus paludicola

In addition to these vascular plants, small mats of *Riccia striata* (Hepaticae) occur occasionally.

On wet mud marginal to reedswamp, where vegetation has been removed, a small decumbent herb, *Bacopa monnieri* is common in limited localities. It is probable that such situations are very lightly brackish. *Aster squamatus,* mentioned in Section 4.3.2.2.7 (page 67), is seasonally dominant in disturbed moist parts marginal to *Phragmites australis* Reedswamp.

Several climbing herbs occur commonly on *P. australis* or its associates in marginal communities. The more common of these include:

Cynanchum schistoglossum
Ipomoea cairica
I. congesta
Melanthera scandens subsp. *dregei* (a scrambler)
Mikania cordata
Tylophora badia var. *latifolia*
Vigna luteola

Others which sometimes occur on these plants, but are more common on the more porous or better drained soils include:

- *Aneilema aequinoctiale*
- *Cardiospermum halicacabum* (frequently where disturbed)
- *Ceratiosicyos laevis* (frequently where disturbed)
- *Cissampelos mucronata*
- *Convolvulus farinosus*
- *Ipomoea alba*
- *I. wightii*
- *Macrotyloma axillare* var. *axillare*
- *Rhynchosia caribaea* var. *picta*
- *Vigna vexillata*

Succession from reedswamp communities to more mesophytic communities depends upon a reduction on the water-table. This may result from natural or, more frequently, artificial drainage. It also is effected by general accretion. In this latter regard the texture of the material and the rate of accretion, particularly if this happens to be of porous material, are of paramount importance. It has been mentioned already that where accretion is rapid this is generally localized, leading to an impediment in former drainage. Thus conditions suitable for the development of reedswamp may be present for long periods beyond the deposited material, unless local drainage is improved.

On the better drained soils these communities frequently pass into *Phragmites mauritianus* Communities or, depending upon edaphic conditions, into various low-lying grassland, scrub or woodland communities.

4.4.3 Streambank herb communities

Reference has already been made to the more hygrophilous members of the streambank communities. These include various anchored emergent hydrophytes and many of those listed as components of reedswamp marginal communities. Their occurrence depends upon the fluctuations in stream flow, water-level and rate of accretion. The angle of slope of the banks and the water-holding capacity of the substrate, which are related to the above factors, also govern the composition of the communities and the rate of succession.

In muddy soils, more or less at water level, *Rumex nepalensis* is frequently locally dominant. In the study area this is also where streambank communities are periodically cleared, thus this increase in abundance is probably dependent upon such disturbance and the removal of competitors. A large tufted grass, *Paspalum urvillei*, also occurs in moist soils, generally a little higher than *R. nepalensis*, and likewise is more abundant where there has been disturbance. Where soil is exposed, various bryophytes often occur. These include *Lophocolea* spp. (Hepaticae) and various Musci.

Where the banks are of porous sandy material, in addition to the already mentioned *Pycreus mundtii* and less abundant *Leersia hexandra*, grasses are important constituents of the communities above ordinary water-level. Generally becoming dominant above the *P. mundtii* zone is *Hemarthria altissima*. *H. altissima* is not tolerant of too low a water-table. Therefore where porosity and the chance of desiccation is increased, as in the upper parts of the sandy banks, other grasses become dominant. On the upper banks of the Mbokodweni River *Cynodon dactylon*, represented locally by a vigorous form, rapidly covers alluvial soils deposited by flood-waters.

In relatively moist, more clayey or loamy sands *Paspalum paspalodes* is frequently locally dominant on banks of water-courses, particularly where there has been some disturbance.

Becoming dominant in the porous soils is *Phragmites mauritianus*. This generally forms a very dense cover, shading out the other grasses and the majority of the non-scandent herbs.

Further away from the streambanks, themselves, edaphic conditions differ and other communities, discussed below, are able to become established.

4.4.4 *Phragmites mauritianus* Communities

Phragmites mauritianus occurs in porous sandy soils where the water-table is relatively high, but where water does not cover the surface other than for brief periods, and where soil water is not stagnant. Thus it is common on the flood-plains of the main rivers where sands have been deposited. Its best development, however, is along river banks where drainage is good (see Fig. 56).

Because of its extensive rhizome system, its robust culms and its ability to withstand burial by sandy alluvium, *P. mauritianus* is a very effective streambank stabilizer. Along rivers with a heavy sediment load its presence on the banks encourages the development of natural levees. If the deposited material is sufficiently well drained, *P. mauritianus* is frequently the first perennial to appear. This is mainly due to rapid growth from buried parts.

P. mauritianus generally occurs in dense stands 2-5 m tall, but it has been measured up to 5,8 m tall as a relict in low-lying open woodland and scrub. The shade cast by *P. mauritianus* is generally sufficient to exclude subordinates from the denser communities. One of the more common and shade-tolerant subordinates is *Laportea peduncularis* which is frequently semi-scandent where light intensites are reduced. Climbers are common and include the various species already listed for the reedswamp marginal communities.

Where the canopy is somewhat open, several grasses occur with *P. mauritianus*. In the lower-lying parts, where soil-water relations are improved, *Stenotaphrum secundatum* frequently forms a continuous ground layer. With continued improvement to the water-holding capacity of the soil, *P. mauritianus* is eventually ousted. It will occur, however, with hygrophilous herbs as the understorey in moist parts where drainage is not unduly restricted.

With a lowering of the water-table more mesophytic herbs, shrubs or trees are able to invade. In sandy soils the early grassland communities are generally dominated by *Imperata cylindrica*. Replacement of *P. mauritianus* by grassland or open scrub is accelerated by fire (see Fig. 57).

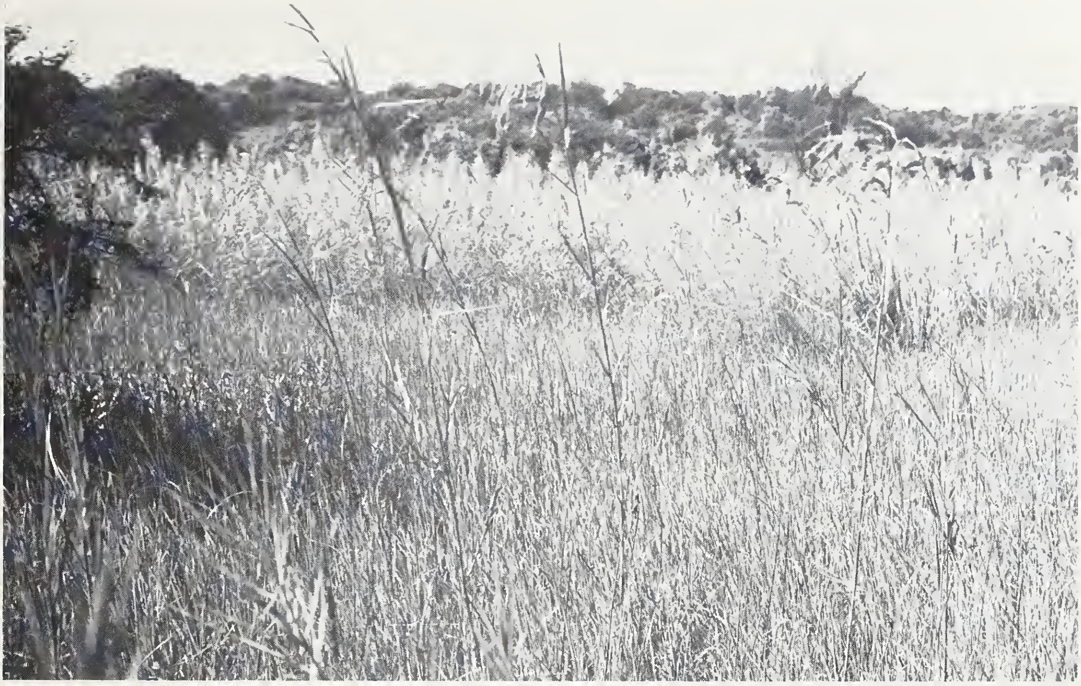

FIG. 57 - Early flood-plain communities. View into dense *Phragmites australis* Consocies in depression beyond deposits of sandy alluvium. Scattered *P. mauritianus* in shorter grassland, especially in foreground, in better drained soil. Grasses: *Imperata cylindrica* dominant, *Ischaemum arcuatum* in shade on left, *Cympogon validus* (large tuft, right middle distance) and adjacent tufted *Digitaria macroglossa*. Other grasses not clearly shown: *Chloris gayana, Bothriochloa glabra* and *Hemarthria altissima*. Associated herbs: leafless *Cyperus natalensis* (plentiful), *Cassia plumosa* var. *plumosa, Crotalaria lanceolata* and *Rhynchosia caribaea* var. *picta* (trailing). Woody invaders: *Acacia nilotica* subsp. *kraussiana* on extreme left and much smaller *Lantana camara, Psidium guajava* and *Phoenix reclinata*. Majority of *L. camara* and few small *P. guajava* killed by fire approximately 8 months prior to photo (taken in autumn)

In the immediate vicinity of stream banks, where drainage is good, as other environmental conditions improve for these invaders, various trees invade directly *P. mauritianus* Consocies.

4.4.5 Low-lying grassland communities

Throughout the alluvial flats there are various grassland communities. These are seral to scrub and woodland communities. The composition of the grassland communities is primarily edaphically controlled, but it is further modified by fires or other forms of disturbance.

Where the water-table is relatively high, but not excessive, and where soil-water movement is slow, the grassland communities are well developed. In such situations shrub or tree invasion is slow. This is mainly because of the edaphic conditions which are unfavourable for many of the invaders. It is also because of the relative frequency of fires which are deleterious to these or other invaders more tolerant of the edaphic conditions. The grasses that develop on these soils are mainly those which produce much combustible material, particularly in the dry season. Secondary grassland communities are well developed in old agricultural lands or where other forms of disturbance have caused the direct removal of woody plants.

The basic pattern of primary succession is as follows. In the lowest parts, extending into brackish soils, *Stenotaphrum secundatum* is the dominant grass. Where conditions are fresher and soils not as clayey, *Hemarthria altissima* is locally dominant. Occurring with both of these grasses in relatively moist, fresh situations is *Paspalum scrobiculatum*, although this is generally where there has been some disturbance. With a slight drop in the permanent water-table, but where soil-water relations are still somewhat moist, *Ischaemum arcuatum* becomes dominant. *I. arcuatum* varies in growth-form with soil drainage, reaching its maximum height in the more porous, better drained soils.

With a rise in soil level, the rhizomatous *Imperata cylindrica* becomes the dominant grass. This is particularly the case on the poorer, more porous soils. In somewhat better soils, *Cynodon dactylon* is an associate or it may be locally dominant. *Digitaria longiflora* occurs as an associate of *C. dactylon* and, while widespread, it is nowhere abundant or dominant. In recent years, a robust form of *C. dactylon* has become locally dominant in the Mbokodweni valley, as mentioned already. Another grass of similar low sandy soils is *Dactyloctenium geminatum*; in the study area, however, this was very localized.

As edaphic conditions improve, succession passes to mixed grassland communities which are dominated by tufted grasses. The more important and widespread of these grasses include:

Digitaria macroglossa
Aristida junciformis subsp. *junciformis*
Chloris gayana
Cymbopogon excavatus
C. validus
Eragrostis capensis
E. curvula (especially where disturbed)
Hyparrhenia filipendula var. *pilosa*
Panicum maximum
Setaria sphacelata

Other grasses occurring in these mixed communities include less common tufted species or stoloniferous or weak-stemmed species which occur as subordinates. These include:

Bothriochloa glabra (localized)
Dactyloctenium australe
Digitaria diversinervis (generally later)
D. macroglossa
D. smutsii
Ehrharta erecta var. *natalensis* (generally lightly shaded)
Eragrostis chapelieri
E. ciliaris
Melica racemosa
Perotis patens
Rhynchelytrum repens
Sacciolepis curvata
Sporobolus fimbriatus (occasional)
Tricholaena monachne

Of these grasses, *Digitaria macroglossa* is the most widespread in primary communities. This generally becomes the initial dominant. Physiognomically and ecologically similar to *D. macroglossa* is *D. smutsii* which is locally dominant in coarse sandy alluvium on the lower Mbokodweni flood-plain.

Following *D. macroglossa* or other tufted grasses in dominance is the robust *Cymbopogon validus*. This frequently invades *Imperata cylindrica* or shorter grassland directly. *C. validus* is the dominant in the final stages of the more mesophytic grassland prior to invasion by scrub or woodland communities.

Figs 45 and 57 illustrate some of these communities.

The main variations of the above general pattern include the following communities or facies. *Paspalum urvillei* is sometimes locally dominant in moist soils marginal to marsh or reedswamp communities, particularly where there has been some disturbance. The robust *Miscanthidium capense* is occasionally locally dominant in low-lying fresh parts. *Hyparrhenia filipendula* var. *pilosa* becomes locally dominant where fire is a frequent feature and where soils are not unduly poor. *Panicum maximum* is often dominant in improved soils, particularly in secondary succession or where fires are very infrequent.

Several ruderal grasses occur in disturbed habitats covering a wide variety of edaphic conditions.

Digitaria scalarum is common and, in parts, is locally dominant on a former wartime airstrip where it was probably deliberately planted during the early 1940's. It is much reduced nowadays, having been invaded by more robust species.

Emphasis has been placed on the grass components of these seral communities. Various Cyperaceae are, however, important and sometimes locally dominant.

Mention has already been made (page 67) of the occurrence of *Fimbristylis ferruginea* in brackish parts. This also occurs with freshwater hygrophilous grasses, but is not as common in such situations as it is in the brackish parts. *F. dichotoma* and, in wetter parts, *F. complanata* are, hoewever, more frequent in low-lying grassland where the water-table is relatively high, at least seasonally so. More abundant than these and occurring as a co-dominant with the more hygrophilous grasses, or even dominating them in parts, is *Cyperus denudatus* var. *sphaerospermus*. In the low-lying parts three large tufted sedges occur. These are, in order of abundance in the study area, *Mariscus riparius, Cyperus textilis* and *C. sexangularis*. These dominate the shorter grasses in scattered open communities in relatively moist parts. *M. riparius* forms more conspicuous communities seral between hygrophilous grasses and *Cymbopogon validus* grassland.

In the more porous soils *Cyperus corymbosus* and, more plentifully, *C. natalensis* occur as associates or local dominants in mixed low-lying grassland. *C. corymbosus* occurs where the water-table is more consistently higher than where *C. natalensis* occurs. *C. natalensis*, as mentioned earlier, has a variable growth form, being relatively short and leafy in the drier sandy soils, while it is taller and leafless in the somewhat moister soils and where the density of the grasses is higher. *C. natalensis* occurs with *Imperata cylindrica* and the shorter tufted grasses, eventually being shaded out by *C. validus* or the more robust forbs or woody invaders.

Amongst the early grasses colonizing sandy soils, *Bulbostylis contexta* and *Fimbristylis hispidula* are common associates. *B. contexta* occurs also in short mixed tufted grassland where soils have improved. Other associates of low-lying grassland on improved soils include *Cyperus obtusiflorus, C. tenax, Kyllinga odorata, K. erecta, Mariscus dubius* , *M. sieberanus* and *M. vestitus*.

As with the grasses, depending upon edaphic conditions, several other Cyperaceae occur in disturbed parts. Of these, *Cyperus distans* and *Pycreus ferrugineus* more generally occur with hygrophilous or semi-hygrophilous grasses while others such as *C. compressus, C. difformis, C. esculentus, C. rotundus* and *Pycreus polystachyos* more generally occur as secondary pioneers in moist or relatively moist soils.

The associated forbs of the low-lying grasslands are more numerous than those of any of the previously discussed grassland communities. Although a large number of species are common to the communities of the alluvial flats and those described earlier, several have been recorded from the flats only. These include not only the more hygrophilous members, but also several from the more mesic communities. The associated forbs are particularly well developed in parts where edaphic factors and fire or other forms of disturbance prevent or retard succession to closed communities. The greatest abundance occurs in open grassland communities or where only the shorter tufted grasses are dominant. The more robust forbs and suffrutices which offer more direct competition to the grasses and act as precursors to scrub or woodland communities are better developed where fire is minimal.

The following list is of relatively short herbs occurring in the earlier or shorter grassland communities. Those with (+) occur mainly in relatively moist parts, those with (–) occur mainly on the better drained sands, subject to desiccation.

(+) *Acalypha ecklonii*
Aeschynomene micrantha
Ambrosia artemisiifolia
Androcymbium decipiens
(+) *Apium leptophyllum*
(+) *Aristea ecklonii*
Asystasia gangetica
Australina acuminata
(+) *Blumea mollis*
Bulbine asphodeloides
(-) *Carpobrotus dimidiatus*
Cassia plumosa var. *plumosa*
Centella coriacea
Chaetacanthus setiger
(+) *Cirsium vulgare*
Commelina africana
(+) *C. diffusa*
C. erecta
Conyza bonariensis
(-) *C. canadensis*
(+) *Conyza chilensis*
C. floribundus
(+) *C. pinnata*
(+) *C. ulmifolia*
Crinum macowanii
Crotalaria lanceolata
Cucumis anguria var. *longipes*
(+) *Diclis reptans*
Desmodium canum
(+) *D. hirtum*
(-) *Dichondra repens*
(+) *Diodia natalensis*
Dipcadi viride
(+) *Disa polygonoides*
Drimiopsis maxima
(+) *Eriosema parviflorum* var. *parviflorum*
(+) *E. squarrosum* var. *squarrosum*
Eriospermum natalense
Eulophia speciosa
(+) *Dyschoriste depressa*
Gerbera piloselloides
Gladiolus natalensis
Gloriosa superba
Gnaphalium luteo-album
G. oligandrum
G. pensylvanicum
Hebenstreitia comosa
Helichrysum asperum
(-) *H. decorum*
H. longifolium
H. nudifolium var. *nudifolium*
H. ruderale
(-) *H. teretifolium*
Heliophila subulata
Hermannia grandistipula
Hewittia sublobata
Hybanthus parviflorus
(+) *Hypoxis angustifolia* var. *angustifolia*
H. rooperi
Indigofera spicata
(-) *Kalanchoe rotundifolia* var. *genuina*
Kohautia virgata
Ledebouria cooperi
L. sp.
(-) *Lightfootia denticulata*
(-) *Limeum viscosum* subsp. *viscosum* var. *kraussii*
(+) *Lobelia anceps*
(-) *L. coronopifolia*
(+) *L. erinus*
(-) *Manulea parviflora*
Meremmia tridentata subsp. *angustifolia*
(-) *Nemesia denticulata*
(-) *Oenothera affinis*
O. sp. poss. *O. biennis*
Oldenlandia affinis
(+) *O. cephalotes*
O. herbacea
Ornithogalum virens
(-) *Othonna carnosa* var. *discoidea*
Oxalis corniculata
(+) *Pelargonium grossularioides*
(+) *Pentodon pentander*
Phyla nodiflora
Physalis viscosa
(+) *Phyllanthus burchellii*
Polygala hottentotta
Priva cordifolia var. *abyssinica*
Salacia kraussii (shrublet)
Scabiosa columbaria
Selago woodii
Senecio madagascariensis
S. variabilis
Silene burchellii
Sonchus dregeanus
S. integrifolius var. *integrifolius*
S. wilmsii
Stachys aethiopica
Trachyandra asperata
Tragia durbanensis
(-) *Tridax procumbens*
Vigna unguiculata
Wahlenbergia undulata
Walafrida densiflora (rare)
Zornia capensis subsp. *capensis*

In addition to the autotrophic herbs, four partial parasites occur on the roots of grasses or their associates in these early low-lying communities. These are *Alectra sessiliflora* var. *sessiliflora, Rhamphicarpa tubulosa, Striga asiatica* and *Thesium asterias.* A total parasite, *Cuscuta campestris,* occurs occasionally in these communities.

In relatively moist parts, ephemeral tall herbs temporarily dominate shorter grasses, particularly where there has been some form of disturbance. Such herbs include *Aeschynomene uniflora* var. *uniflora, Asclepias physocarpa, Aster squamatus, Hibiscus cannabinus, Senecio polyanthemoides* and the sub-woody *Sesbania bispinosa* var. *bispinosa.*

A few naturalized aliens which more frequently occur as ruderals have been included in the above list. This is because they occur in early communities with native plants. In deliberately cleared places, the number of ruderals is very much increased.

Other short herbs, generally becoming established on more mesic soils or in denser communities, include *Cyphia corylifolia, Galopina aspera* and *Phaulopsis imbricata.*

These relatively short grassland communities are invaded by taller or more robust forbs which oust the more heliophilous shorter grasses and associates. In the moister parts such invasion frequently precedes invasion by the more mesophytic bunch grasses. Such tall herbs include *Conyza scabrida, Eriosema psoraleoides, Ethulia conyzoides, Indigofera arrecta, Pluchea dioscoridis, Tephrosia polystachya, Triumfetta pilosa* var. *effusa* and *T. rhomboidea. Berkheya bipinnatifida* subsp. *bipinnatifida*, which is more robust than the above, eventually becomes the dominant in the moister parts (see next section).

In the more mesic or drier habitats the more robust herbs occur with or succeed the establishment of the tufted grasses. The later invaders, both erect and scandent forms, include:

Abrus precatorius subsp. *africanus*
Aerva lanata (rare)
Aloe saponaria
Anthospermum littoreum (sandy soils subjected to light salt-spray)
Asparagus africanus
A. virgatus
Barleria obtusa
Berkheya discolor
Cissampelos mucronata
Crotalaria grantiana
C. natalitia
C. pallida var. *pallida*
Eupatorium odoratum
Felicia erigeroides
Helichrysum cymosum
H. kraussii (non-shaded sands)
H. panduratum
Hibiscus fuscus
H. surattensis
Indigofera grata
Indigofera inhambanensis
I. trita
I. williamsonii
Leonotis dysophylla
L. leonurus var. *leonurus*
Lessertia sp. cf. *L. harveyana*
Macrotyloma axillare var. *axillare*
Nidorella auriculata
Peristrophe natalensis
Pyrenacantha scandens
Rhynchosia caribaea var. *picta*
Rumex sagittatus
Senecio chrysocoma (open, sandy soils)
Sida acuta
S. dregei
Sutera floribunda
S. kraussiana
Smilax kraussiana
Thunbergia dregeana
Vernonia angulifolia
V. adoensis

In addition to angiosperms, Bryophyta and Pteridophyta are represented in these low-lying grassland communities. In relatively moist parts, but above the parts occupied by the marsh communities, *Anthoceros* sp. is a common subordinate in grassland. This frequently occurs where there has been some disturbance, but where not fully exposed to direct insolation. *Bryum argenteum* and other unidentified matforming Musci occur where soils are a little sandier and drier. These occur commonly in the more open parts of low-lying *Imperata cylindrica* grassland or *Imperata* - leafless *Cyperus natalensis* Communities. *Ophioglossum* sp. is an occasional subordinate in moister parts of these same communities; *O. polyphyllum* occurs in drier situations and in open parts of more advanced communities. *Equisetum ramosissimum* occurs early in open communities on sandy soils, sometimes locally abundant where there has been disturbance. Although generally erect, *E. ramosissimum* occurs in a semi-scandent form as a relict in scrub or thicket communities on the flood-plains. *Pellaea viridis* is frequent as a subordinate in the more advanced grassland communities where surface soils do not dry out excessively. *P. viridis* persists into the closed woodland or early forest communities. *Pteridium aquilinum* occurs in later grassland communities, particularly those invaded by shrubs and periodically burnt. In the study area, *P. aquilinum* was localized in distribution.

4.4.6 Low-lying scrub communities

With a lowering of the water-table or with an improvement to drainage, suffrutices, shrubs and trees are able to invade the earlier established communities. If drainage is adequate, mesophytic grassland communities may be omitted in the succession.

In places where accretion has been very rapid and the material left by flood-waters is essentially sand, the colonizers and subsequent invaders are mainly those species which were recorded for the earlier communities of the white sand dunes. This is especially so where salt-spray is carried inland by on-shore winds. The successional relationships are likewise similar. However, the presence of more hygrophilous plants in these communities, at least after the canopy has closed, is indicative of the better soil-water relations of these parts compared with the white dunes.

Although there is much variation in the edaphic conditions, the invaders are more generally somewhat hygrophilous, at least in the low-lying parts. This includes the hollows between low ridges of alluvium deposited by subsequential floods.

Succession is mainly from an initially open scrub dominated by suffrutescent or soft-wooded spreading or erect forms to closed communities later dominated by more-slowly growing trees. With the continuous increase in height of the canopy there is an increase in complexity of the structure of the communities leading via woodland eventually to forest.

The earlier suffrutescent or brittle-stemmed invaders include the following. Those with (+) occur in relatively moist parts, those with (–) occur mainly in well-drained soils, subject to desiccation.

(+) *Rubus rigidus*
(+) *Berkheya bipinnatifida* subsp. *bipinnatifida*
Lantana camara
Eupatorium odoratum
(–) *Artemisia afra* (rare)
Cassia didymobotrya
C. floribunda
C. hirsuta
(+) *Cestrum laevigatum*
Chrysanthemoides monilifera subsp. *rotundata* (where water-table not too high)
Crotalaria capensis (occasional)
Hermannia velutina (occasional)
(+) *Hibiscus diversifolius* subsp. *diversifolius*
Lasiosiphon meisnerianus
(–) *Passerina rigida* (open sands)
Ricinus communis
Sesbania punicea
Solanum mauritianum

Of these, *R. rigidus* is generally the more important of the initial invaders in damp places.

More widespread and becoming the initial dominants in a low dense scrub up to 2,5-3 m tall are *B. bipinnatifida* subsp. *bipinnatifida* (emergent up to approximately 4 m tall) and the lower rambling *L. camara*. *B. bipinnatifida* subsp. *bipinnatifida* generally occurs in damper parts than *L. camara* which is also the more heliophilous of the two. The scrub produced by one or both of these two species casts a denser shade than that of the majority of other early scrub communities. A common associate of this scrub, in damper parts, is the twiner *Ipomoea congesta* which contributes to the shade factor.

E. odoratum occurs on the better drained soils occupied by the above two, but is more abundant and better developed as a component of communities marginal to woodland or early forest.

R. communis and *S. mauritianum* both occur more frequently where there has been disturbance and are particularly well represented in flood-disturbed riparian communities, especially where soils are sandy. In such places, they occur as fast-growing trees up to just over 8 m and 6 m tall, respectively. Frequently occurring with them is *Cestrum laevigatum* which is more common in damper, more poorly drained parts. It is also more shade-tolerant than these two. *C. laevigatum* frequently dominates *Berkheya-Lantana* Scrub prior to the community being dominated by taller trees.

Sesbania punicea, up to 2,5 m tall, has become locally dominant in the last decade in open communities where soils are sandy and water is available. This occurs particularly in disturbed parts and is well represented in grassland communities near human habitation on the flats and in early communities on flood-disturbed banks of the Mbokodweni River.

Cassia didymobotrya is best represented as an invader of *Phragmites mauritianus* Communities on the upper banks of the Mbokodweni River where it occurs up to 4,8 m tall.

Also occurring in early scrub in low-lying moist parts, in sandy soil, is *Tithonia diversifolia*, a robust herb which was measured up to 3,3 m tall. It is also frequent in early riparian scrub on the banks of the upper Mbokodweni River. In such a locality it is rather a subordinate in early riparian open woodland.

In addition to these fast-growing suffrutices and shrubs there are several heliophilous trees and harder-wooded shrubs which occur in these early communities. Other components are those which are shade-tolerant or shade-dependent in their earlier stages of development, thus representing later phases in succession. A few occur more or less equally as well in shade as in open situations, provided that water is adequate in the open parts.

Of the heliophilous trees and shrubs the earliest to become established in the low-lying parts include *Hibiscus tiliaceus, Acacia robusta* subsp. *clavigera, Casuarina equisetifolia, Ficus capensis, Phoenix reclinata* and *Salix babylonica.*

H. tiliaceus occurs mainly in brackish parts, but it will occur in places that are not too dry above the highest tidal levels, apparently where airborne salt-spray is the main source of supply of salt. Where hydroseral communities are concerned, *H. tiliaceus* generally invades *Stenotaphrum secundatum* Grassland or, sometimes, *Imperata cylindrica* Grassland. However, once established, it spreads and frequently shades out neighbouring more mesophytic communities, thus facilitating invasion by shade-tolerant forest precursor species. Initially *H. tiliaceus* forms a generally discontinuous scrub but, with growth, this community frequently closes to form a low woodland, discussed later.

A. robusta subsp. *clavigera* occurs on a variety of substrates that are not excessively porous unless water is readily available, even if this is only seasonal. It is common as the initial invader of *Stenotaphrum secundatum* Grassland, occurring a little higher than *H. tiliaceus,* but extending down into apparently lightly brackish situations. It is well developed along riverbanks and on the flood-plains where drainage is free. It is nowhere abundant, but it dominates the communities in which it occurs up to closed woodland when it is generally shaded out by taller trees.

Except where deliberately planted, *C. equisetifolia* occurs occasionally or locally frequently in the low-lying parts. It invades short grassland or open places disturbed by man or floods.

Ficus capensis and *Phoenix reclinata* are both shade-tolerant and become co-dominants in hygrophilous scrub or woodland communities. They also invade grassland communities before the earlier mentioned scrub, where the water-table is high. Although they often occur in close proximity to one another, *P. reclinata* generally occurs on better drained soils.

Salix babylonica represented by a solitary specimen, became established originally on the banks of a small watercourse before the establishment of taller hygrophilous herbs or shrubs.

Other trees or shrubs which invade grassland or early scrub communities in the moister parts include the following. These are mostly tolerant of light shade as well:

Bridelia micrantha
Clerodendrum glabrum
Combretum bracteosum
(mainly streambank)
C. kraussii
Melia azedarach
Morus sp. prob. *M. alba*
(occasional)
Psidium guajava
Rauvolfia caffra (rare)
Syzygium cordatum
Trema orientalis

These merge with the more mesophytic heliophilous invaders of grassland which, in better drained parts, include the psammophytes referred to earlier. The specific composition of these woody plant invaders is similar to those that occur on red sands where salt-spray is not an important factor (see pages 57 to 58), with, however, the lack of *Ziziphus mucronata. Albizia adianthifolia* is less widespread, occuring mainly on better drained soils. Common additions include, on mesic soils, *Acacia karroo* (especially where mesophytic grasses periodically burnt), *Maytenus nemorosa, Rhus rehmanniana* and, in sandy alluvium on flood-plains, *A. nilotica* subsp. ***kraussiana*** **(see Fig.** 57). Others include *Acacia mearnsii* (occasional), *Combretum molle* (rare), *Eucalyptus robusta* (locally frequent) and, in secondary grassland, *Schinus terebinthifolius. Anastrabe integerrima* (one only) and *Heteropyxis natalensis* (few) occur where there has been so much disturbance that it is not possible to state whether they invade open communities directly or whether they become established in light shade.

With the establishment of these various trees, shrubs and suffrutices the majority of the members of the earlier communities are ousted. As mentioned, these mixed communities, with the loss of shorter heliophytes and the addition of shade-dependent species, develop directly into woodland communities.

Subordinates include relicts of the grassland or earlier communities, particularly those climbers which are tolerant of changes in edaphic factors.

Other subordinates not mentioned earlier include *Hibiscus calyphyllus*, a suffrutex. In light shade *Dactyloctenium australe* becomes the dominant grass, while others include *Digitaria diversinervis, Ehrharta erecta* var. *natalensis, Panicum deustum* and, occasionally, *P. maximum. Setaria chevalieri*, a robust tufted grass, occurs in damper, generally lightly shaded parts. *Cyperus albostriatus* occurs in the field layer in closed scrub. Forbs include the following: *Achyranthes aspera* (moist), *Anthericum saundersiae, Anomatheca laxa, Asparagus densiflorus, A. virgatus, Crassula sarmentosa, C.* sp. nr. *C. natalensis* (lower Mbokodweni Valley only), *Endostemon obtusifolius* (upper Mbokodweni riparian scrub), *Euphorbia kraussiana* and *Sansevieria hyacinthoides.*

Additional subordinates, including climbers, are dealt with more fully under woodland communities. A scandent shrub which is generally ousted by the time that woodland communities are able to become established is *Caesalpinia decapetala*. This alien occurs occasionally in riverain scrub.

In lightly shaded, low-lying sandy soils a mat-forming moss, *Weisia crispata*, occurs occasionally.

4.4.7 Low-lying woodland and early forest communities

In addition to the few more hygrophilous trees mentioned above as being tolerant of light shade, several of the more mesophytic woody invaders of open communities also have seedlings which develop in light shade. Other species, representing all the major types of growth form, develop better, or exclusively, in shade of the scrub communities. With growth, the tree members, together with the taller components of the earlier established communities, become the dominants in early woodland which replaces the more heliophilous scrub. The more common of the earlier additions include *Erythrina lysistemon, Allophylus natalensis* and *Strelitzia nicolai.*

Climbers and scramblers are well represented amongst these early invaders. These contribute towards shading out the earlier established vegetation. Furthermore, the more robust members frequently offer serious competition to the early woodland dominants. Although these are listed more fully below, *Cyphostemma hypoleucum* and *Rhus nebulosa* are among the more common and widespread of the robust species occurring in early closed communities. The former is particularly umbrageous and occurs more frequently in places where freshwater is more readily available than does *R. nebulosa.*

The height of the canopy and growth rate in general is maximal where freshwater is readily available, drainage is free and disturbance is minimal.

Owing to the amount of past disturbance there is a considerable admixture of plants representing various stages in later scrub and woodland succession leading, in those parts which have had the longest respite from fires or felling, to early Coast Forest.

As the cover increases, the shorter, less shade-tolerant species die out. These include all of those listed earlier as being fast-growing shrubs as well as the following trees which are important in early seral communities: *Melia azedarach, Psidium guajava, Trema orientalis, Acacia karroo, Hibiscus tiliaceus* (spreading branches generally reduced earlier), *Brachylaena discolor* and *Acacia robusta* subsp. *clavigera.* These are listed in the approximate order in which they are ousted from woodland communities, as height increases. These are followed by *Allophylus natalensis, Erythrina lysistemon* and *Albizia adianthifolia.* Relicts of these occur in closed communities, if they are able to grow tall enough, but their seedlings are not able to become established in the deeper shade of more mature undisturbed communities.

The tallest trees in these low-lying communities are aliens, either deliberately planted and subsequently locally spread in open or lightly shaded parts, or have been able to become established in flood disturbed parts. These include *Bambusa balcooa*, up to c. 16 m tall, which occurs as a few isolated clumps with very local spread by rhizomes where not burnt; *Casuarina equisetifolia*, up to about 19 m tall (feral) in open communities, occurring only as a relict in closed communities, in a few parts; *Eucalyptus andreana*, up to 14,3 m tall, originally planted, but very locally spread in scrub or early woodland where lightly shaded, and *E. robusta*, originally planted, with occasional spread into disturbed open parts, the feral specimens being up to approximately 16 m tall. Of the native species, the tallest measured were *Trichilia dregeana* 15 m (stem 64 cm d.b.h) and *Syzygium cordatum* 12,2 m (95 cm d.b.h). These were both in open disturbed communities on the upper flood-plain of the Mbokodweni River.

Where less disturbed, the woodland communities form a closed canopy mainly from 6 m to 10 m tall with emergents extending a little higher. In the better developed communites, these emergents are up to approximately 11 m in height. Emergents over 10 m in height include:

Albizia adianthifolia
Bridelia micrantha
Combretum kraussii
Ekebergia capensis
Phoenix reclinata
Protorhus longifolia
Rhus chirindensis forma *legatii*
Sclerocarya caffra (occasional)
Strelitzia nicolai
Syzygium cordatum
Trichilia dregeana

Of these, *A. adianthifolia* and *S. caffra* are relicts of earlier open communities. Similarly, although to much lesser degrees, are the remainder except *P. longifolia* which becomes dominant in early forest, *R. chirindensis* f. *legatii* and, becoming dominant later, *Trichilia dregeana.*

Upper canopy species 8 m to 10 m tall include the above as well as:

Acacia karroo (early)
A. robusta subsp. *clavigera* (early)
Allophylus natalensis (early)
Antidesma venosum (early)
Apodytes dimidiata subsp. *dimidiata*
Bersama lucens (early)
Brachylaena discolor (early, somewhat scandent in dense communities)
Canthium inerme (early)
C. obovatum
Celtis africana
Chaetachme aristata (later)
Clerodendrum glabrum (early)
Combretum molle (rare, open)
Commiphora harveyi
C. woodii (rare)
Cordia caffra
Croton sylvaticus (only south of Mbokodweni River)
Erythrina lysistemon (early)
Euclea natalensis
Fagara capensis
Ficus capensis (particularly in wet parts where base buttressed, early)
F. burkei
Hibiscus tiliaceus (early)
Melia azedarach (early)
Mimusops caffra
Olea woodiana
Phyllanthus discoideus (only Mbokodweni valley)
Psidium guajava (early)
Rauvolfia caffra (rare, early)
Sideroxylon inerme
Strychnos madagascariensis (later)
Trema orientalis (early)

Those marked "early" become established in open or only lightly shaded parts. They are ousted as the canopy increases in height and the community becomes more complex. With time, the others are likely to grow taller. Those marked "later" are essentially forest species which only appear as the communities mature.

Additional canopy trees 5,5 m to 7 m tall include *Allophylus melanocarpus, Cryptocarya latifolia* and *Ficus craterostoma* which occur in riparian communities along the upper Sipingo River. Others occurring generally in more open communities include *Acacia mearnsii* (occasional), *A. sieberana* var. *woodii* (rare), *Heteropyxis natalensis* (occasional), *Morus* sp. possibly *M. alba* and *Sapium integerrimum.*

Sub-canopy trees or tall shrubs 5 m to 9 m tall include:

Allophylus natalensis
Baphia racemosa (later)
Cestrum laevigatum (mostly open)
Deinbollia oblongifolia
Dovyalis longispina
Diospyros natalensis subsp. *natalensis* (later)
Maytenus nemorosa (mostly open)
M. procumbens (lightly shaded)
Mimusops obovata
Teclea gerrardii (later)
Turraea floribunda (frequently canopy)

Smaller trees and shrubs 1,5 m to 5,5 m tall include:

Acokanthera oblongifolia
Burchellia bubalina (light shade, occasional)
Canthium spinosum (light shade)
Carissa bispinosa var. *acuminata* (into deep shade)
C. macrocarpa (mostly open)
Clausena anisata
Dovyalis rhamnoides (into deep shade)
Dracaena hookerana (all closed stages to deep shade)
Drypetes arguta (rare, later)
D. natalensis (later)
Erythroxylum emarginatum (later)
Eugenia capensis (relict)
E. natalitia (later)
Euphorbia ingens (occasional juvenile in early woodland)
Kraussia floribunda
Lagynias lasiantha
Monanthotaxis caffra (generally scandent, later)
Ochna natalitia
Pavetta alexandrae (marginal)
P. revoluta (marginal)
Peddiea africana (common, later)
Psychotria capensis (later)
Putterlickia verrucosa
Rhus natalensis (marginal, scandent)
Tricalysia sonderana (light shade, early)
Trimeria grandifolia
Turraea obtusifolia
Uvaria caffra (generally scandent, later)
Xeromphis obovata (light shade)
X. rudis

In addition to these smaller trees and shrubs, seedlings or saplings of the canopy trees occur in these lower synusiae. Depending upon the amount of shade present, these include all except those relicts marked "early" in the tree lists. Even some of these, as mentioned earlier, are able to become established in light shade. Those marked "later" generally occur in deeper shade and on more improved soils. In addition to those that have been listed above, a sapling of *Linociera peglerae*, another forest species, was recorded from moderate shade.

The composition of the field layer varies considerably. In wetter parts, *Thelypteris dentata* is common in light to moderate shade. In low-lying damp parts in early woodland, *Achyranthes aspera* is generally dominant in a poorly developed field layer. *Setaria chevalieri* which, more generally, occurs in marginal communities also occurs occasionally in light shade in moister parts.

In light shade of early woodland in more mesic parts, the field layer is dominated by grasses. These include *Dactyloctenium australe, Digitaria diversinervis, Ehrharta erecta, Panicum chusqueoides, P. deustum* and, as a relict, *P. maximum.*

Associated forbs include:

Anomatheca laxa
Anthericum saundersiae
Asparagus densiflorus
Asystasia gangetica
Celosia trigyna
Chlorophytum modestum
Commelina benghalensis
Crassula sarmentosa
Drimiopsis maculata
D. maxima
Droguetia urticaefolia
Haemanthus magnificus
Hibiscus pedunculatus
Isoglossa stipitata
Rhinacanthus gracilis,

and a sedge, *Cyperus albostriatus.*

In more shaded situations the field layer includes the following:

Berkheya maritima
Bonatea speciosa
Chlorophytum comosum (in parts very common)
Coleotrype natalensis
Dicliptera heterostegia
Dietes vegeta
Haemanthus albomaculatus (in parts abundant, forming a complete cover to soil in moderate shade)
H. puniceus (common associate of *H. albomaculatus*, but extends into deeper shade
Isoglossa ciliata
I. woodii (periodically dominant except in very deep shade)
Laportea grossa (deeper shade)
L. peduncularis
Oplismenus hirtellus
Panicum laticomum
Plectranthus ambiguus (occasional)
P. madagascariensis
Pseudechinolaena polystachya
Sansevieria hyacinthoides
Stylochiton natalense

In addition to these angiosperms the following Pteridophyta occur in the field layer, mostly in the lower-lying parts: *Doryopteris concolor, Pellaea viridis, Phymatodes scolopendria* and, in deeper shade, *Asplenium prionitis* and *Microsorium punctatum* which, more frequently, occurs as an epiphyte.

Climbers and scramblers are well represented. The more robust or umbrageous members which reach the upper canopy frequently cause deformity of the upper branches of the trees of this stratum and also shade out the more heliophilous members. Included in this synusia are the following, those with (x) are the more robust or umbrageous upper canopy species:

(x) *Acacia kraussiana*
Acridocarpus natalitius (woody, later, occasional)
(x) *Allocassine laurifolia* (later)
Aneilema aequinoctiale (damp margin, low)
Asparagus falcatus var. *falcatus*
I. cairica
I. congesta (early, marginal)
I. ficifolia (early, marginal)
Jasminum multipartitum (early)
Lagenaria mascarena (low-lying, early)

A. setaceus
Behnia reticulata
Canavalia bonariensis (low-lying)
Capparis brassii
(x) *C. fascicularis* var. *zeyheri*
(x) *C. sepiaria* var. *citrifolia*
(x) *Cardiospermum grandiflorum* (disturbed margin)
Ceropegia linearis
Cissampelos torulosa (later)
Cissus fragilis (all closed stages)
Coccinia palmata
Ctenomeria capensis (later)
Cynanchum ellipticum
C. obtusifolium (marginal)
Cyphostemma flaviflorum (early, relatively low)
(x) *C. hypoleucum* (all closed stages, mostly early)
(x) *Dalbergia armata*
(x) *D. obovata*
Dalechampia capensis (marginal, low)
Dioscorea cotonifolia
D. crinita
(x) *Diospyros villosa* var. *villosa* (occasional)
(x) *Embelia ruminata*
(x) *Entada spicata*
Eupatorium odoratum (early)
(x) *Flagellaria guineensis*
Glycine wightii (disturbed margin, early)
(x) *Grewia caffra*
(x) *G. occidentalis*
(x) *Hewittia sublobata* (early, marginal)
Ipomoea alba (damp margin, low)
Lagynias lasiantha (occasional, later)
(x) *Lantana camara* (early, relatively low)
(x) *Microglossa mespilifolia* (early, marginal)
(x) *Mikania cordata* (early, damp margin)
(x) *Monanthotaxis caffra* (later)
(x) *Mukia maderaspatana* (low, margin, damp)
Pergularia daemia (disturbed, early, occasional)
Pupalia atropurpurea (early)
Pyrenacantha scandens
(x) *Rhoicissus digitata* (mostly early)
(x) *R. rhomboidea*
(x) *R. tomentosa*
(x) *Rhus natalensis*
(x) *R. nebulosa* (mostly early)
Rubia cordifolia (early)
Rumex sagittatus (marginal, frequently disturbed)
(x) *Scutia myrtina* (early onwards)
(x) *Secamone alpinii*
Senecio brachypodus
S. deltoideus (mostly marginal)
S. helminthioides (later)
S. macroglossoides (later)
S. tamoides (later)
(x) *Smilax kraussiana* (early onwards)
Tecomaria capensis (mostly relatively dry margin)
Tragia durbanensis (low, early)
(x) *Uvaria caffra* (later)
(x) *Vernonia angulifolia* (mostly early)
Zehneria parvifolia (early, low)

Hemi-epiphytes are represented by *Ficus burtt-davyi* which is frequent and, occurring occasionally, *F. vogelii, F. burkei* and *F. natalensis.*

Pseudo-epiphytes include *Phymatodes scolopendria* and *Microgramma lycopodioides* both of which occur as true epiphytes as well. Other true epiphytes include *Cyrtorchis arcuata, Microsorium punctatum, Nephrolepis cordifolia* and *Phlebodium aureum. C. arcuata* is well represented in low-lying woodland where the general growth rate and succession is slow. *M. punctatum* occurs in deep shade in the more mature or moister communities. The aliens, *N. cordifolia* and *P. aureum*, are localized and occur on *Phoenix reclinata* in hygrophilous woodland.

The non-vascular epiphytes were not studied in any detail. Those that were recorded include a lichen, *Ramalina* sp., on exposed branches in marginal scrub. The following bryophytes were recorded from shaded branches in more mature communities: *Lejeunea wilmsii* and *Frullania* sp. (Hepaticae); *Fissidens* sp. and *Sematophyllum brachycarpum* (Musci).

The only vascular plant parasite that was recorded from these low-lying woodland or early forest communities was *Loranthus dregei.* This hemi-parasite occurs on the upper branches of several species and is particularly common on *Hibiscus tiliaceus* and *Melia azedarach* in marginal or semi-open communities.

4.4.8 Subseres

It has been pointed out that there has been much disturbance to all communities in the low-lying parts. In view of this, and the fact that there has been repeated disturbance of varying degrees and extent, there is a considerable admixture of secondary and primary elements in the vegetation throughout these parts. Consequently, apart from early ruderal populations, these were treated together in the previous sections.

The specific composition of the communities which are able to become established in disturbed parts varies with environmental conditions. Of these, the more important are edaphic conditions, the degree to which disturbance has taken place and the repetition of disturbance. Where the vegetation cover to non-submerged soils has been removed, ruderal herbs are the main colonizers. Aliens are particularly common in such communities. Taking all the low-lying communities as a whole, almost 250 species were recorded from early communities in disturbed places; of these approximately 50% were aliens. The more important families were Compositae (20% of native and alien species) and Gramineae (15,5%); Solanaceae followed with 5,5%. In improved soils, *Conyza bonariensis* and *C. floribunda* generally dominate initial secondary communities. *C. floribunda* under optimum conditions is particularly robust and occurs in dense stands with individuals up to 2,3 m tall. In somewhat more porous substrates *C. canadensis* is an associate of these or it dominates the early communities. These three alien *Conyza* spp. are annuals.

As more perennials replace the initial annuals in these communities, native species continuously become more important. Increasingly more robust aliens, however, which dominate subseral communities include *Eupatorium odoratum, Lantana camara, Cestrum laevigatum, Psidium guajava* and *Melia azedarach.* In recent years, as has been mentioned already, *E. odoratum* and *L. camara* have become more important as precursors to forest. These are all eventually replaced by native species in more mature communities.

In regard to the grasses, apart from smaller ruderals, local dominance by the following more common species generally indicates disturbance. Some of these, and others, were mentioned when discussing earlier communities: *Paspalum urvillei* (wet-damp places); *P. paspalodes* (wet parts);

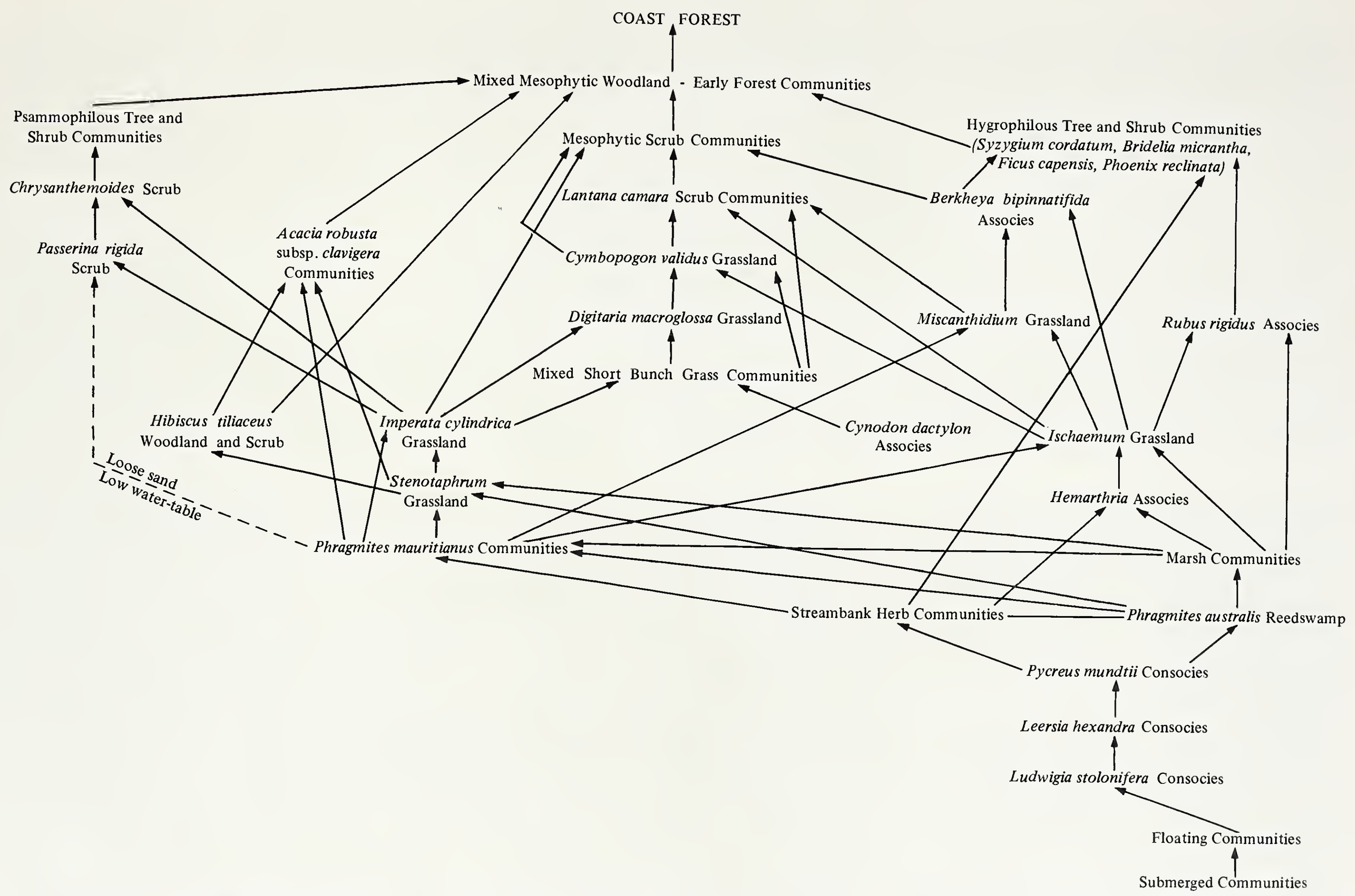
COAST FOREST
Mixed Mesophytic Woodland - Early Forest Communities
Psammophilous Tree and Shrub Communities
Hygrophilous Tree and Shrub Communities (Syzygium cordatum, Bridelia micrantha, Ficus capensis, Phoenix reclinata)
Mesophytic Scrub Communities
Chrysanthemoides Scrub
Lantana camara Scrub Communities
Berkheya bipinnatifida Associes
Acacia robusta subsp. clavigera Communities
Passerina rigida Scrub
Cymbopogon validus Grassland
Digitaria macroglossa Grassland
Miscanthidium Grassland
Rubus rigidus Associes
Mixed Short Bunch Grass Communities
Hibiscus tiliaceus Woodland and Scrub
Imperata cylindrica Grassland
Cynodon dactylon Associes
Ischaemum Grassland
Loose sand
Low water-table
Stenotaphrum Grassland
Hemarthria Associes
Phragmites mauritianus Communities
Marsh Communities
Streambank Herb Communities
Phragmites australis Reedswamp
Pycreus mundtii Consocies
Leersia hexandra Consocies
Ludwigia stolonifera Consocies
Floating Communities
Submerged Communities

FIG. 58 - Simplified suggested interrelations of hydroseral communities; primary communities, except for *Lantana camara* Scrub. Maximum freshwater in bottom right corner

Andropogon eucomus (moist parts); *Sorghum verticilliflorum* (moist parts); *Imperata cylindrica* (sandy soils).

In fallow fields, *Panicum maximum* generally becomes the dominant grass or initially dominant perennial. Succession from here follows a suffrutex - shrub - tree sequence where the dominants vary with edaphic factors, generally with *Lantana camara* or *Chrysanthemoides monilifera* subsp. *rotundata* initially dominant and leading via *Brachylaena discolor* to mixed woodland communities, as already described.

In low-lying fallow fields on somewhat muddy soils, *Stenotaphrum secundatum* frequently becomes a dominant. This is invaded by the more hygrophilous tufted grasses and more robust plants. The succession more generally shows a sequence of communities dominated progressively by *Rubus rigidus, Psidium guajava, Ficus capensis* and *Bridelia micrantha,* followed by more mesophytic trees.

As already mentioned, where fire is an important factor, tufted grasses dominate the communities and associated forbs are well represented. Invading shrubs are generally kept short by the fires. Any trees that are able to become established are frequently isolated, having been able to escape the main effect of the fires by some, often slight, improvement in environmental conditions. These generally form the nuclei of thickets which eventually spread and replace the heliophilous grassland communities. Repeated fires, with sufficient combustible material available at the time, prevent such closure. In the discussion of the grassland and scrub communities reference was made to the various invaders under these circumstances. In the study area, *Acacia karroo* is the dominant in scrub and early woodland communities invading mesic grassland where fires occur periodically.

4.4.9 Community interrelations

The community interrelations which have been suggested and discussed throughout the above sections are illustrated in Fig. 58.

In primary communities there is marked edaphic control. Until accretion or drainage has been sufficient to cause the substrate to be exposed, the communities remain dominated by herbs, the most robust of which is *Phragmites australis.*

The porosity of the substrate, the availability of freshwater, drainage and the rate of accretion, all of which are interrelated, influence the succession.

Hibiscus tiliaceus and *Acacia robusta* subsp. *clavigera* extend into the lowest-lying parts which are also brackish. They do not, however, occur where the water-table is permanently high. The more hygrophilous common trees are *Ficus capensis, Phoenix reclinata, Bridelia micrantha* and *Syzygium cordatum. Rauvolfia caffra* (rare) and *Combretum kraussii* occur where there is better drainage.

Where accretion has been particularly rapid and soils (generally sands) are left well above the ordinary water-table, the communities and the succession are similar to those that occur on other sands in the study area.

Between these two extremes there are many mesic herbs, shrubs and trees which appear in the communities seral to forest. Grassland communities are well developed where drainage is poor.

In regions of rapid accretion, successional relations tend to be complicated due to variations in the material deposited and in the topographical gradient. Amongst other effects, any unevenness of the surface results in considerable micro-environmental differences within a small area. This leads to the establishment of communities which are initially quite different from one another even though they may be contiguous; xerophilous psammophytes occur on the better drained, poor sands while hygrophilous plants often become established in the depressions.

Disturbance in the form of cutting and burning, in particular, has caused retrogression towards more open communities. In subsequent succession, especially where there has been clearing, a large number of naturalized aliens have become established. These are particularly common amongst the annuals or short-lived perennials. A few aliens are relatively long-lived and frequently form important constituents of the later communities. They are, however, eventually replaced by native species in undisturbed closed woodland or later communities.

4.5 COAST FOREST

With time and improvement to edaphic conditions, as well as with protection from such adverse factors as salt-spray or desiccation, succession passes from the communities described above to forest.

There has been so much disturbance throughout the greater part of the study area that no primary climax community, typical of what it is inferred could develop under mesic conditions, occurs in the area today.

An approach towards such a community was found in Dune Forest on the white sands of Isipingo North. This, however, lacks several of the more mesophytic forest species, and even several which occur on dry slopes of the red sand hills. In view of this and the differences in the seral communities, Dune Forest has been treated as an edaphic climax separate from more mesophytic coast forest.

Where there has been protection from fire or other forms of disturbance, communities in mesic situations grade into mesophytic forest communities, but those existing are considered to be mostly immature. These early forest communities are best developed in the low-lying parts and on the south-facing slopes of Jeffels' Hill, at least until current soil removal destroyed much of the vegetation. These have been discussed in Sections 4.4.7 (page 88) and 4.2.2.2.1.3 (pages 55 to 56). The somewhat less advanced communities on dry slopes (Section 4.2.2.2.2.3) are mentioned briefly on page 59.

In other parts of the study area, forest, or a near-forest climax, has been reached on steep slopes. These are treated as lociations of the inferred climatic climax, namely, Coast Forest.

On seaward slopes, with improvement to environmental conditions, *Mimusops caffra* Transitional Forest grades into Coast Forest, as mentioned on page 48. This is better developed outside the study area. In this succession, in addition to the loss of shorter forest precursor species, there is also a reduction in *M. caffra* and an increase in the number of other dominants. Apart from the taller of the species listed on page 49, *Protorhus longifolia* and, later, *Podocarpus latifolius* and *Manilkara discolor* occur as dominants in these forest communities. Within the study area, *Linociera peglerae* and *Olea woodiana* are rare additions to the upper canopy. Amongst the sub-canopy or occasional canopy trees, *Drypetes natalensis* and *Cola natalensis* become more important than in the *M. caffra* Transitional Communities. Additional sub-canopy shorter trees or shrubs include *Cussonia nicholsonii* and *Erythroxylum emarginatum.*

The above species, with the exception of *P. latifolius*, occur in the forest communities on the warm dry slopes as well. Other differences include the lack of *Strelitzia nicolai* and the presence in different synusiae of several species which are limited to these inland-facing slopes.

On these dry slopes the dominants occur as emergents above a continuous canopy. The height of the canopy and that of the emergents varies with local conditions. The emergents are up to approximately 12 m tall and include:

Canthium obovatum
Celtis africana
Chaetachme aristata
Commiphora harveyi
Euphorbia ingens (better developed outside the study area)
Manilkara discolor (only Donsagolo and better developed outside the study area)
Mimusops caffra
Olea woodiana
Protorhus longifolia
Sideroxylon inerme
Strychnos decussata
S. madagascariensis
Ziziphus mucronata

The more abundant of these include *Commiphora harveyi, Strychnos madagascariensis* and *Celtis africana* (particularly on lower slopes) .

Upper canopy trees include the above together with:

Acacia robusta subsp. *clavigera* (rare)
Albizia adianthifolia (lower margin)
Antidesma venosum (lower margins)
Apodytes dimidiata subsp. *dimidiata* (occasional)
Canthium inerme
Clerodendrum glabrum (occasional)
Cordia caffra
Diospyros natalensis subsp. *natalensis*
Drypetes natalensis (mostly sub-canopy)
Erythrina lysistemon
Euclea natalensis
Eugenia natalitia (frequently sub-canopy)
Fagara capensis
Ochna barbosae (locally common on Isipingo Beach hill only)
Scolopia zeyheri (rare)
Teclea gerrardii

The upper canopy trees generally form a dense cover beneath which lower strata are poorly developed. In other parts, generally where the slope is very steep, there is better penetration of light and more shrubs or small trees occur.

Sub-canopy trees vary in height with the canopy. These are mostly less than 6 m tall, but some occur up to 7,6 m tall which is taller than the canopy in other parts. The taller members include:

Allophylus natalensis (mostly marginal)
Baphia racemosa
Cola natalensis (only Donsagolo)
Cussonia nicholsonii (only Donsagolo)
Deinbollia oblongifolia
Drypetes arguta (mostly shorter)
Mimusops obovata
Ochna natalitia
Strychnos henningsii (only Isipingo Beach)
S. usambarensis (only Isipingo Beach)
Urera tenax (only very steep dry slope, Isipingo Beach)

Smaller trees and shrubs include:

Acalypha glabrata (base only)
A. sonderiana
Acokanthera oblongifolia
Allophylus melanocarpus
Carissa bispinosa var. *acuminata*
Dovyalis rhamnoides
D. longispina
Erythroxylum emarginatum
Kraussia floribunda
Lagynias lasiantha (semi-scandent)
Maytenus nemorosa
Peddiea africana (occasional)
Psychotria capensis
Putterlickia verrucosa
Rothmannia globosa
Turraea floribunda
T. obtusifolia
Vangueria chartacea
Xeromphis obovata
X. rudis (occasional)

The field layer is poorly developed. There are frequent bare parts, especially where the canopy is dense. The members of this synusia include:

Achyranthes aspera (occasional)
Australina acuminata
Celosia trigyna
Coleotrype natalensis
Crocosmia aurea (more mesic parts)
Cyperus albostriatus
Dactyloctenium australe (light shade)
Dietes vegeta
Digitaria diversinervis
Dracaena hookerana
Drimiopsis maculata
Haemanthus puniceus
Isoglossa woodii
Laportea grossa
L. peduncularis
Panicum chusqueoides
P. deustum
P. laticomum
Plectranthus verticillatus
Psilotrichum africanum
Sansevieria hyacinthoides

The only fern recorded for the study area was *Phymatodes scolopendria* which is rare in the dry aspect communities.

The field layer is better represented where the slope is not so steep, particularly near the base and where there has been disturbance.

Scramblers and climbers are well represented, particularly in marginal communities and where disturbed. Two species, *Ipomoea mauritiana* and *Secamone frutescens,* occur only on the dry slopes, others are common to the other woodland or forest communities already described. However, the actual specific composition differs from any of the other individual communities. The other members of this synusia include the following, those with (c) are upper canopy species:

(c) *Acacia kraussiana*
(c) *Acridocarpus natalitius*
(c) *Adenia gummifera* var. *gummifera*
(c) *Allocassine laurifolium*
Asparagus africanus (occasional)
A. falcatus var. *falcatus*
A. setaceus
Behnia reticulata
(c) *Capparis brassii*
(c) *C. fascicularis* var. *zeyheri*
(c) *C. sepiaria* var. *citrifolia*
Cissus fragilis
Coccinia palmata
Cynanchum ellipticum
(c) *Cyphostemma hypoleucum*
(c) *Dalbergia armata*
(c) *D. obovata*
Dalechampia capensis (mostly marginal)
Dioscorea crinita
D. sylvatica var. *paniculata*
(c) *Diospyros villosa* var. *villosa*
(c) *Embelia ruminata*
(c) *Flagellaria guineensis*
(c) *Grewia caffra*
(c) *G. occidentalis*
(c) *Jasminum multipartitum*
Momordica involucrata (mostly marginal)
(c) *Monanthotaxis caffra*
Pupalia atropurpurea (mostly marginal)
Pyrenacantha scandens
(c) *Rhoicissus rhomboidea*
(c) *R. tomentosa*
(c) *Rhus nebulosa*
Sarcostemma viminale (steep Isipingo Beach hill, rare elsewhere)
(c) *Scutia myrtina*
(c) *Senecio brachypodus*
S. tamoides
(c) *Urera cameroonensis* (rare)
(c) *Uvaria caffra*
Vernonia angulifolia (mostly marginal)

Hemi-epiphytes include *Ficus burtt-davyi* which after rooting in the soil generally extends as a semi-scandent shrub into the upper canopy. *F. natalensis* was recorded only as a small epiphyte.

True epiphytes include *Cyrtorchis arcuata, Microcoelia exilis* (Isipingo Beach only), *Mystacidium flanaganii* and *Polystachya sandersonii.*

Hemi-parasites include *Loranthus dregei* (mostly marginal) and *L. quinquenervis.*

Taking into account the earlier discussed communities and the composition of the above-mentioned communities, it is inferred that the climatic climax, Coast Forest, would contain not only most of those species recorded for Dune Forest, but also many other more mesophytic species in all synusiae.

In addition to those species listed on pages 33 and 34, the dominants of such a forest are likely to include *Croton sylvaticus* (relatively early), *Protorhus longifolia* (relatively early), *Rhus chirindensis* forma *legatii, Trichilia dregeana* and *Phyllanthus discoideus* which, however, is not well represented in the study area. Where soil-water relations are improved *Bridelia micrantha* would occur, at least in the earlier stages. In somewhat moister parts *Syzygium cordatum* would be an associate. *Albizia adianthifolia* would occur in mesic situations only as a relict in closed forest. *Mimusops caffra*, as pointed out earlier, would occur as a dominant in salt-spray faciations, but is not likely to occur in climax forest in more mesic parts.

These species are already present in the study area. The inclusion of others, represented in neighbouring relict communities, would be merely speculative, however likely it is that a few may eventually occur in the inferred climatic climax forest.

Biotic factors

In dealing with biotic factors an attempt has been made to consider these as completely as possible in order to omit nothing that may add to knowledge of the plant ecology and ecological history of the study area, in view of the marked changes it is now undergoing at the hands of man.

Unless otherwise stated, all records are personal observations made by the author in the study area itself.

5.1 PLANTS

Dependence of plants on other plants for protection against various environmental factors, and competition amongst plants, is discussed in the previous Chapter. While it is appreciated that saprophytes are very important in helping to break down dead tissue, thus influencing succession in any given area, it is considered that they have only an indirect effect on individual plants, so they are omitted from the present discussion. Parasites on the other hand, having a more direct effect on individual living plants, are mentioned.

5.1.1 Fungal parasites

In this study no serious attention has been given to this group, although it might be mentioned that Doidge (Bothalia 5, 1950) listed several from "Isipingo", including the type of her *Isipinga areolata* (Ascomycetes) on *Euclea natalensis*. *Ward* 6532b, as yet unidentified, is a parasite on leaves of *Panicum maximum* from a somewhat shaded situation: there would appear to be no wide infestation of this fungus, either on that particular host or elsewhere.

Claviceps sp(p). were found on the inflorescences of a few grasses such as *Sorghum verticilliflorum, Paspalum urvillei, P. paspalodes* and *Panicum maximum*, in low-lying or moist areas. *Paspalum paspalodes* was sometimes locally fairly heavily infested, while the others were only occasionally parasitized. The *Claviceps* sp(p). in turn appeared frequently to be parasitized by other fungi, or these may have been saprophytic on honey-dew.

5.1.2 Heterotrophic vascular plants

The following plants were recorded as being parasitic. These were either terrestrial and parasitic upon the roots of their hosts, or aerial and mostly attached to stems, although *Cuscuta campestris* sometimes had haustoria penetrating into petioles or developed on laminae of its hosts. Holoparasites: *Cuscuta campestris, Hyobanche fulleri.* Hemiparasites: *Loranthus dregei, L. kraussianus, L. quinquenervis, Viscum nervosum, Thesium asterias, Alectra sessiliflora* var. *sessiliflora, Rhamphicarpa tubulosa, Striga asiatica.* For details of these, see Chapter 6.

The most noticeable effect of these parasites on their hosts is that growth of organs of the host beyond the point of contact becomes markedly restricted, often to such a degree that eventual death of the distal part occurs. This was frequently observed with *Loranthus* spp. particularly the very common *L. dregei* on host trees. It is suggested that heavy infestation by a parasite could bring about indirectly the death of the host through causing it to succumb to competition. This seemed to have been the case with some specimens of *Hibiscus tiliaceus*, a heliophyte, which, because of heavy infestation by *Loranthus dregei* were not able to grow sufficiently rapidly to prevent other trees in their immediate vicinity from shading them out.

5.2 ANIMALS

It is not intended that all animals recorded from the Isipingo Beach area should be discussed or even listed here, but rather only those observed actually feeding on, or otherwise influencing, plants in the study area itself.

5.2.1 Mollusca

Gastropods, terrestrial and aquatic, both fresh and salt water forms, occur throughout the area except where they might suffer from desiccation.

Periwinkles, *Tectarius natalensis, Littorina obesa* and *L. africana* occur mostly on the seaward faces of supralittoral rocks where they feed on algae, apparently mostly epilithic or even shallowly endolithic Cyanophyta.

Cerithidea decollata occurs abundantly in mangrove associations where it feeds on microscopic algae on the surface of mud. Apart from eating algal pioneers of exposed brack clayey soils, this mollusc has another ecological effect in that its faecal casts are sometimes so numerous that they alter the surface of the soil by roughening it. Thus penetration by water is facilitated, resulting in increased leaching if this is by rain water, and also, when not inundated, aeration of the subsurface layer is probably improved.

5.2.2 Arthropoda

5.2.2.1 CRUSTACEA

Crabs of various types occur throughout the aquatic and low-lying areas. Fiddler crabs, *Uca* spp., were common in mud, or sandy mud, mostly marginal to mangroves, especially *Avicennia marina*. In recent years their numbers have dwindled, and now they seem to have disappeared. Their burrows aided in aeration and drainage of the soil.

Another mangrove crab, *Sesarma meinerti*, is still very common, mainly in the upper intertidal regions, or slightly above this level. These are important, particularly for soil turnover and aeration, since their burrows can be very numerous. The upper lip of a burrow may rise several centimetres above the surface of the surrounding soil (see Fig. 40). If this surface is already approximately at extreme high tide level, the raised lip or mound is then unaffected by salt water. With leaching of salts and a reduction in the clay fraction (through rain water action), such mounds would be able to be colonized by a wider range of plants than would be possible without this increased height. Furthermore, the crabs carry plant debris, as well as weak or dead animals, into their burrows, thus improving the organic content of the soil.

5.2.2.2 INSECTA

The following is merely a broad outline of the various orders encountered and, although it is inadequate, it may serve to indicate the importance of various insects. Nocturnal insects, in particular, require considerably more investigation. Perhaps one of the more interesting aspects of this particular section is the recording of insect visitors to plants considered to be wind-pollinated, such as members of the Gramineae (these plants are mentioned individually in Chapter 6). Whilst these insects gather pollen as food they are likely to act as accidental agents of pollination for these wind-pollinated flowers.

Throughout this section dealing with insects where reference is made to some insect merely visiting a flower, the inference is that these visitors may act as agents of pollination.

5.2.2.2.1 Orthoptera

Whilst there has been no infestation in recent years, the study area was subjected to periodic invasions of red locusts in the past. The last major invasion was late 1933 - early 1934.* The only other local record is of a juvenile Locustidae eating staminal filaments of *Eleocharis limosa*.

5.2.2.2.2 Thysanoptera

Thrips have been recorded from the flowers of several plants including *Pennisetum purpureum, Acacia sieberana* var. *woodii, Isoglossa woodii* and several members of the Compositae. These small insects often had pollen grains adhering to their bodies and no doubt acted as agents of pollination, especially in those plants where flowers are closely aggregated.

5.2.2.2.3 Hemiptera

Spit-bugs (nymphs of Cercopidae) were observed frequently massed in their characteristic froth on young branches of trees such as *Celtis africana* and *Erythrina lysistemon* from which they sucked juice. Sometimes the distal parts of these branches had died, possibly as either a direct or indirect effect of such feeding.

Aphid nymphs seemed to show preference for certain plant taxa. While generic or specific identification was unable to be made, what appeared to be nymphs of a single species were observed sucking juice from the stems and peduncles of several members of Asclepiadaceae: *Asclepias physocarpa, Cynanchum obtusifolium, C. schistoglossum* and *Tylophora badia* var. *latifolia*.

Members of the Aphidae, Membracidae and Coccidae are often attended by ants, which, as they walk over flowers, possibly act as accidental agents of pollination.

Adult Hemiptera were observed sucking juice from stems of *Bidens pilosa* and, by so doing, caused death to distal tips. Other adult Hemiptera visited flowers of *Schinus terebinthifolius, Cardiospermum grandiflorum, Deinbollia oblongifolia* and *Cynanchum obtusifolium*, possibly bringing about pollination.

5.2.2.2.4 Lepidoptera

Moths and butterflies are very important in both larval and adult stages. Larvae eat leaves, young stems and flower parts or burrow into stems, whilst adults are visitors to flowers, eaters of fruit and possible transmitters of fungal spores.

Moths, mostly unidentified, were observed taking honey-dew from *Claviceps*-infested spikelets of *Paspalum paspalodes* and visiting flowers of *Bauhinia tomentosa, Croton sylvaticus, Cynanchum obtusifolium, Clerodendrum glabrum (Euchromia amoena), Isoglossa woodii* (Sphyngidae), *Canthium obovatum (Euchromia amoena), Vernonia angulifolia* (several, including *Amata* sp.), *Conyza*

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* The South African Sugar Year Book and General Directory, 1934 and 1935

scabrida, Senecio chrysocoma, S. deltoideus, S. madagascariensis. In addition *Egybolis vaillantina* took juice from ripe *Lantana camara* fruits.

In regard to the butterflies, the only larva specifically identified was that of *Danaus chrysippus* (African Monarch) which ate leaves, peduncles and calyces of *Asclepias physocarpa*. The adult was seen to visit flowers of this plant for nectar, as well as those of *Euphorbia heterophylla, E. hirta, Lantana camara, Priva cordifolia* var. *abyssinica, Scabiosa columbaria, Lobelia coronopifolia, Eupatorium odoratum, Bidens pilosa* and *Tridax procumbens*. Plants whose flowers have been recorded as being visited by other butterflies in the Isipingo Beach area are *Aloe thraskii (Charaxes* sp., and Pieridae), *Loranthus dregei* (Pieridae), *Carpobrotus dimidiatus* (Lycaenidae), *Stellaria media* (Lycaenidae), *Kalanchoe rotundifolia* var. *genuina* (Lycaenidae), *Albizia adianthifolia* (Pieridae), *Acacia kraussiana* (Lycaenidae), *Oxalis latifolia* (Pieridae), *Scutia myrtina* (Lycaenidae), *Lasiosiphon meisnerianus* (several), *Combretum kraussii* (several), *Plumbago auriculata* (several), *Carissa macrocarpa (Papilio nireus lyaeus), Cynanchum obtusifolium* (Pieridae), *Lantana camara* (several), *Barleria obtusa* (Pieridae), *Peristrophe natalensis* (Pieridae), *Isoglossa woodii* (Pieridae), *Scabiosa columbaria* (several), *Vernonia angulifolia* (several), *Conyza scabrida* (Lycaenidae), *Bidens pilosa* (Acraeidae), *Chrysanthemoides monilifera* subsp. *rotundata* (Lycaenidae and Pieridae).

Unidentified lepidopteran larvae have been observed defoliating *Erythrina lysistemon* and *Ledebouria cooperi*.

5.2.2.2.5 Coleoptera

Larvae of an unidentified beetle occasionally defoliated *Sesbania bispinosa* var. *bispinosa;* another unidentified larva was recorded from the central part of the living stem of *Cyphostemma flaviflorum*; others were frequent in dead woody stems, rotting vegetation and faeces, while weevils were recorded from seeds of *Abutilon grandiflorum* and *Hibiscus tiliaceus*.

Adults visited flowers for nectar and fed on parts (especially of corolla and androecium) not only of large showy flowers such as *Hibiscus* spp., *Oenothera* sp. or *Ipomoea* spp., but also of much smaller flowers such as *Polygonum pulchrum, P. senegalense* and *Hermannia velutina*.

In addition, adult beetles were recorded from flowers of the following: *Digitaria macroglossa, Cenchrus brownii, Phragmites mauritianus, Carpobrotus dimidiatus, Nymphaea capensis, Heliophila scandens, Geranium ornithopodum, Croton sylvaticus, Scutia myrtina, Pavonia dregei, Rhizophora mucronata* (eating filaments), *Combretum kraussii, Ipomoea wightii* (eating essential organs and corolla base), *Hebenstreitia comosa, Asystasia gangetica* (eating essential organs and corolla base), *Vernonia angulifolia, Helichrysum decorum, Chrysanthemoides monilifera,* subsp. *rotundata, Gazania rigens* var. *uniflora, Launaea sarmentosa*.

5.2.2.2.6 Hymenoptera

All information given here pertains only to adults.

Ants (super-family Formicoidea) fed on nectar from flowers, during which operation they may have acted directly as agents of pollination, or from extra-floral nectaries in which case they may have acted as chance agents of pollination in their wanderings.

Flowers of the following plants were visited by various ants: *Phoenix reclinata, Pupalia atropurpurea, Achyropsis leptostachya, Krauseola mosambicina, Ricinus communis, Euphorbia geniculata, E. hirta, Scutia myrtina, Cyphostemma flaviflorum, C. hypoleucum, Cola natalensis, Rhizophora mucronata, Bruguiera gymnorrhiza, Apium graveolens, Cynanchum obtusifolium, Clerodendrum glabrum, Leonotis dysophylla* (after corolla, androecium and style had fallen), *Richardia brasiliensis* (mostly after corolla with androecium had fallen), *Conyza floribunda, Chrysanthemoides monilifera* subsp. *rotundata*.

Ants were observed visiting extra-floral nectaries of *Eulophia speciosa* (at base of flower buds), *Canavalia maritima* (outside and bases of flowers), *Ipomoea mauritiana* (immediately below calyx in buds) and *Lagenaria mascarena* (on leaves and calyces).

In addition to taking nectar, ants took honey-dew from *Claviceps*-infested grasses, for example *Paspalum paspalodes*. It was not confirmed whether they acted as transmitters of the spores of this fungus.

Apart from the above observations it was noted that ants attended nymphs, or adults, of several Hemiptera: Aphidae, Membracidae and Coccidae. It is possible that during this attendance they may have acted as accidental agents of pollination when the Hemiptera were situated close to the flowers of their food plants.

Wasps (super-family Vespoidea) are also nectar feeders, and visited flowers of the following: *Pupalia atropurpurea, Achyropsis leptostachya, Heliophila scandens, Acacia kraussiana, Euphorbia geniculata, E. heterophylla, Schinus terebinthifolius, Scutia myrtina, Cissus fragilis, Lasiosiphon meisnerianus, Combretum kraussii, Apium graveolens, Cynanchum obtusifolium, Verbena bonariensis, Selago woodii, Richardia brasiliensis, Nidorella linifolia, Conyza floribunda, Senecio chrysocoma, S. madagascariensis, S. polyanthemoides*. Some plants, such as *Scutia myrtina*, were visited by many different wasps, in other cases the insects were more specific. Wasps also took juices from fruits, especially when over-ripe, or from wounds in stems.

Members of the super-family Apoidea (bees) visited flowers of many species for nectar, for pollen or for both pollen and nectar. The only attempt at specific identification was for the common honey bee, *Apis mellifica*, for which records were made of visits to the following flowers:

Nectar

- *Achyropsis leptostachya*
- *Heliophila scandens*
- *Rubus rigidus*
- *Scutia myrtina*
- *Cyphostemma hypoleucum*
- *Strychnos spinosa*
- *Cynanchum obtusifolium*
- *Ipomoea pes-caprae*
- *Phyla nodiflora*
- *Clerodendrum glabrum*
- *Stachys aethiopica*
- *Bacopa monnieri*
- *Isoglossa woodii*
- *Canthium obovatum*
- *Citrullus lanatus*
- *Vernonia angulifolia*
- *Eupatorium odoratum*
- *Conyza floribunda*
- *Blumea mollis*
- *Helichrysum cymosum*
- *Senecio chrysocoma*
- *S. madagascariensis*

Pollen

- *Phoenix reclinata*
- *Morus* sp. cf. *M. alba*
- *Rumex sagittatus*
- *Carpobrotus dimidiatus*
- *Ricinus communis*
- *Acalypha glabrata*
- *Sclerocarya caffra*
- *Schinus terebinthifolius*
- *Solanum mauritianum*
- *Othonna carnosa* var. *discoidea*

Both

- *Aloe thraskii*
- *Acacia robusta* subsp. *clavigera*
- *Geranium ornithopodum*
- *Euphorbia heterophylla*
- *Triumfetta rhomboidea*
- *Peristrophe natalensis*
- *Scabiosa columbaria*
- *Brachylaena discolor*
- *Senecio polyanthemoides*
- *Chrysanthemoides monilifera* subsp. *rotundata*
- *Lactuca indica*

Flowers of *Hypoxis rooperi* and *Acacia kraussiana* were also visited by *Apis mellifica*, but in each case the purpose of the visit could not be determined with certainty. It appeared as though the bees were taking nectar, although both pollen and nectar might have been taken.

Other bees, from large carpenter bees to small stingless bees, were recorded visiting flowers of the following for nectar, pollen or for both:

Nectar

- *Pupalia atropurpurea*
- *Aptenia cordifolia*
- *Crotalaria capensis*
- *Eriosema squarrosum* var. *squarrosum* (but covered in pollen)
- *Geranium ornithopodum*
- *Pelargonium grossularioides*
- *Acalypha glabrata*
- *Scutia myrtina*
- *Triumfetta rhomboidea*
- *Pavonia dregei*
- *Hibiscus surattensis* (but covered in pollen)
- *Rhizophora mucronata*
- *Cynachum obtusifolium*
- *Stachys aethiopica*
- *Scabiosa columbaria*
- *Lagenaria mascarena*
- *Scaevola thunbergii*
- *Vernonia angulifolia*
- *Senecio madagascariensis*
- *S. polyanthemoides*
- *Osteospermum fruiticosum*
- *Gazania rigens* var. *uniflora*

Pollen

- *Panicum deustum*
- *Digitaria diversinervis*
- *D. sanguinalis*
- *Aloe thraskii*
- *Argemone mexicana*
- *Bauhinia tomentosa*
- *Dalechampia capensis*
- *Hewittia sublobata*
- *Thunbergia dregeana*
- *Melanthera scandens* subsp. *dregei*

Both

- *Carpobrotus dimidiatus*
- *Krauseola mosambicina*
- *Zornia capensis* subsp. *capensis*
- *Helichrysum decorum*
- *Othonna carnosa* var. *discoidea*
- *Chrysanthemoides monilifera* subsp. *rotundata*
- *Launaea sarmentosa*
- *Lactuca indica*

The purpose of the visits to the following flowers was not determined with certainty: *Acacia kraussiana, Lasiosiphon meisnerianus, Solanum mauritianum, Thunbergia alata, Conyza bonariensis* and *Eclipta prostrata*. Flowers of *Panicum maximum* were visited, but this seemed to have been for dew still present on the inflorescence or, perhaps, for some exudate in the dew. Flowers of *Scirpus prolifer* were also visited apparently for pollen.

An interesting anomaly in regard to morphological adaptation to insect visitors was recorded for the flowers of *Zornia capensis* Pers. subsp. *capensis*: this flower was frequently visited by a carpenter bee which, in a rapid movement, depressed the alae and carina, obtained nectar from the base of the stamens and in so doing acted as an agent of pollination; a variation of this was exhibited by a small black bee which, too light to depress the alae, deliberately separated the distal ends of the alae and twisted its body through the opening on to the end of the carina from where it collected pollen.

5.2.2.2.7 Diptera

As Dr B.R. Stuckenberg has pointed out (personal communication, 1969), adult flies of many descriptions will visit flowers and extra-floral nectaries of various plants, whatever is available at the time. While this was confirmed, some flowers seemed to attract a larger number and often a greater variety of flies than other plants available at the time. This was particularly the case for certain members of the Compositae: *Vernonia* spp., *Eupatorium odoratum* and *Senecio* spp.

In addition to taking nectar several flies, particularly Syrphidae and Calliphoridae (Rhiniinae), were frequently observed licking anthers and apparently eating pollen. An examination of the gut contents of a few specimens of *Melanostoma bituberculatum* Loew. (Syrphidae) that had visited *Panicum maximum* revealed that they had ingested pollen grains of this grass, while one specimen contained pollen of a non-grass as well.

Flowers of the following were visited by various flies, either for pollen or for nectar: *Sorghum verticilliflorum, Paspalum urvillei, Panicum maximum, Digitaria scalarum* (apparently), *Pennisetum purpureum, Phoenix reclinata* (female flowers or very early fruit), *Aloe thraskii, Heliophila scandens, Ekebergia capensis, Croton sylvaticus, Sclerocarya caffra, Schinus terebinthifolius, Scutia myrtina, Cyphostemma hypoleucum, Hibiscus surattensis, Trimeria grandifolia, Cynanchum obtusifolium, Phyla nodiflora, Vernonia angulifolia, Eupatorium odoratum, Conyza bonariensis, Sigesbeckia orientalis, Senecio chrysocoma, S. deltoideus, S. madagascariensis, S. polyanthemoides, Othonna carnosa* var. *discoidea*.

Extra-floral nectaries of *Cassia occidentalis* (foliar), *Ipomoea mauritiana* (base of calyx), *Cestrum laevigatum* (bases of flowers and buds) and *Lagenaria mascarena* (calycine) were also visited.

A number of different flies visit fruits, especially when ripe or over-ripe, but the only records made for the study area were of Drosophilidae on ripe fruit of *Lantana camara* and *Solanum mauritianum*.

Fungal parasites or saprophytes associated with *Claviceps* spp., or perhaps the honey-dew itself, on infected grasses were observed being visited (licked) by various flies, but it was not determined whether these flies aided in distribution of these fungi.

5.2.3 Vertebrata

Where Vertebrata are concerned, feeding records from places other than the Isipingo Beach area have been included if both the animal and the food plant have been recorded for the study area.

5.2.3.1 BIRDS

It would appear that almost all fleshy fruits are eaten by some frugivorous bird. In the study area, some records were directly observed, others were obtained by growing plants from seeds contained in bird faeces. By inference many other records could have been included, since young plants of many fruit-bearing species were recorded beneath fruit-bearing trees known to be visited by frugivorous birds. However, since fruit-bats may also have aided in this distribution, such records are excluded in this discussion.

Granivorous birds were not limited to eating fruit of grasses, but were observed also eating fruits and seeds of several other plants, such as composites (fruit) or seeds of amaranths, crucifers, *Stellaria media* and members of Solanaceae. In Zululand, even the small fruits of opened figs were recorded as being eaten by granivorous birds.

In addition to sunbirds, several other birds probe nectariferous flowers as has also been recorded by Oatley (1964) for *Aloe marlothii*. In some species the amount of nectar may be considerably less than would be expected to encourage avian visitors. In this regard, some birds, not only the shorter-beaked birds but also sunbirds, by-pass the anthers and stigma by piercing the outer flower parts to obtain nectar; others eat part or all of the flower itself. Flowers of the following plants occuring in the Isipingo Beach area were observed being visited by those birds whose names are given in brackets. Records from elsewhere and from other people's observations (as acknowledged) have been included only if the birds have been recorded for this locality. *Aloe saponaria* (Olive Sunbird - Durban Bluff); *Aloe thraskii* (Black-eyed Bulbul, Indian Myna, Cape Weaver); *Haemanthus magnificus* (Olive Sunbird - Hluhluwe Game Reserve); *Loranthus dregei* (Olive Sunbird - Hluhluwe Game Reserve; Collared Sunbird - Durban); *Caesalpinia decapetala* (Collared Sunbird, near Umzinto, teste Sprawson, 1968); *Erythrina lysistemon* (Black-eyed Bulbul, Cape White-eye; in Durban - Indian Myna, Cape Weaver, Yellow Weaver; in Zululand - Olive Sunbird, Collared Sunbird); *Bruguiera gymnorrhiza* (Olive Sunbird); *Ipomoea congesta* (Olive Sunbird); *Tecomaria capensis* (Olive Sunbird, Collared Sunbird - Zululand); *Peristrophe natalensis* (Collared Sunbird, in Oribi Gorge, teste Sprawson 1968); *Vangueria infausta* (Black-eyed Bulbul, Sombre Bulbul, Collared Sunbird, Cape White-eye, all in Hluhluwe Game Reserve).

Another influence of birds on vegetation is that some eat vegetative parts of plants and others strip leaves for nesting. Finally, an indirect effect of birds is the enrichment of soils by all birds, not only terrestrial birds, as has been pointed out already by Morss (Journ. Ecol. 15, 1927) and as was seen on low-lying estuarine sand bars on which gulls and other sea birds frequently settle in large numbers.

The following short list of birds is of those which occur in the Isipingo Beach area and for which records of botanical interest were made. The order followed is that of Roberts' Birds of South Africa (1957).

Hagedashia h. hagedish (Latham) - Hadeda - in former years roosted in such numbers on *Bruguiera gymnorrhiza* and *Rhizophora mucronata* (northern end of main Isipingo Lagoon) that individual roosting trees were killed above, or sometimes completely.

Plectropterus gambensis (Linnaeus) - Spurwing Goose - were frequently observed foraging in hygrophilous vegetation, but no specific determination of their food-plants was made.

Various duck and teal were visitors to freshwater suitably covered by vegetation; although the exact food-plants were not observed, Cooper (1968) reported that these take fruit of *Leersia hexandra*, which is common in the areas frequented by these birds.

Porphyrio porphyrio madagascariensis (Latham) - Purple Gallinule - in reed swamps, generally where some open water, elsewhere (Mkuze River mouth) recorded eating tender young stems of *Phragmites australis*.

Charadrius marginatus tenellus Hartlaub - White fronted Sandplover - nests on low strand dunes formed by *Hydrophylax carnosa*.

Streptopelia semitorquata (Rüppell) - Red-eyed Turtle Dove - (mostly in woodland) feeds on various fruits and seeds.

Streptopelia c. capicola (Sundevall) - Cape Turtle Dove - as above.

Stigmatopelia s. senegalensis (Linnaeus) - Laughing Dove - as above, often in built-up areas.

Turtur tympanistria (Temminck & Knip) - Tambourine Dove - in dune forest and woodland-forest; feeds on fallen seeds.

Gallirex p. porphyreolophus (Vigors) - Purple-crested Lourie - in forest and woodland; frugivorous.

Colius striatus minor Cabanis - Speckled Mousebird - in scrub and open woodland; eats fruits, flowers and leaves, elsewhere reported as having probed flowers of *Aloe* spp. (Durban, teste Moll, 1968; Ndumu, Oatley, 1964).

Lybius t. torquatus (Dumont) - Black-collared Barbet - in scrub, woodland and woodland-forest; frugivorous.

Pycnonotus barbartus layardi Guaney - Black-eyed Bulbul - in scrub, woodland and forest canopy; feeds on insects, fruits and flowers, also probes various flowers.

Andropadus i. importunus (Vieillot) - Sombre Bulbul - in scrub, woodland and forest; frugivorous and, outside the study area, was seen to probe flowers.

Cossypha natalensis A. Smith - Natal Robin - in closed scrub, woodland and forest; frugivorous.

Acridotheres tristis (Linnaeus) - Indian Myna - open woody plant communities, forest canopy and built-up areas; frugivorous, insectivorous and probes flowers.

Lamprocolius c. corruscus (Nordmann) - Black-bellied Glossy Starling - scrub, woodland and forest canopy; frugivorous and according to Oatley (1964) probes *Aloe* flowers.

Cyanomitra o. olivacea (A. Smith) - Olive Sunbird - woodland-forest and forest; probes flowers and eats insects.

Anthreptes c. collaris (Vieillot) - Collared Sunbird - in woodland-forest; probes flowers and eats insects.

Zosterops pallidus virens Sundevall - Cape White-eye - scrub, woodland and forest margins or canopy; frugivorous, insectivorous and takes nectar from flowers and extra-floral nectaries.

Passer domesticus indicus Jardine & Selby - House Sparrow - in built-up areas; granivorous and, in Durban, observed eating into nectariferous flower.

Symplectes b. bicolor (Vieillot) - Forest Weaver - woodland and forest; in the St. Lucia Lake area opened mature pods of *Acacia robusta* subsp. *clavigera* and ate seeds and, in Ndumu, Oatley (1964) recorded this as an occasional prober of *Aloe marlothii* flowers.

Hyphanturgus o. ocularius (A. Smith) - Spectacled Weaver - in scrub and woodland, often riparian; in Umzinto area frugivorous (teste Sprawson, 1968) and, in Ndumu, was an "addicted prober" of *Aloe marlothii* flowers (Oatley, 1964).

Ploceus capensis olivaceus (Hahn) - Cape Weaver - in scrub, generally riparian, and woodland; frequent prober of *Aloe thraskii* and *Erythrina lysistemon.*

Ploceus s. subaureus A. Smith - Yellow Weaver - in scrub and woodland, often riparian; granivorous, frugivorous and probes flowers.

Euplectes o. orix (Linnaeus) - Red Bishop Bird - low-lying grassland; granivorous.

Coliuspasser a. axillaris (A. Smith) - Red-shouldered Widow-bird - low-lying grassland; granivorous.

Lonchura cucullata scutata (Heuglin) - Bronze Mannikin - grasslands and open scrub; granivorous, and, in Durban, observed feeding readily on leaves and soft parts of culms of *Cynodon dactylon.*

Serinus mozambicus granti Clancey - Yellow-eye Canary - in open plant communities; eats fruits of grasses, amaranths and composites, small fleshy fruits and, outside the study area, was seen probing flowers and taking termites.

5.2.3.2 MAMMALS, OTHER THAN MAN

The scientific names and arrangement of orders are as given in Ellerman, Morrison-Scott and Hayman in Southern African Mammals (1953).

5.2.3.2.1 Chiroptera

Fruit bats, apparently both *Rousettus aegyptiacus leachii* A. Smith, Cape Fruit-Bat, and *Epomophorus w. wahlbergii* Sundevall, Wahlberg's Epauletted Fruit-Bat, were observed in the Isipingo Beach area. Although observations of actual feeding of these nocturnal animals in the study area have not been made, the fact that seeds or young specimens of fleshy-fruit bearing plants were found clustered beneath a suitable branch suggested that the seeds were dropped by fruit-bats. *E. wahlbergii*, if not the first species also, seems to carry fruit to some suitable perch where, after eating the fleshy part, the seeds are dropped. It is probable, as was mentioned in regard to birds, that most fleshy-fruits are also eaten by fruit bats. In the absence of direct proof but, based on reasons given above, it is suggested that fruit bats aid in the distribution of the following plants in the Isipingo Beach area: *Phoenix reclinata, Strelitzia nicolai, Melia azedarach, Drypetes natalensis* and *Acokanthera oblongifolia*. Elsewhere confirmed records have been made of fruit bats eating fruits of several other trees of which only *Psidium guajava* occurs in a feral state in the Isipingo Beach area.

5.2.3.2.2 Primates

Galago crassicaudatus garnetti Ogilby, Bushbaby, may have disappeared from the Isipingo Beach area. For many years the call of this nocturnal forest- and woodland-dweller has not been heard locally and the last non-captive specimen that the author encountered was in the early 1940's, however this is no proof of absence. Elsewhere it has been observed feeding on fruits of several woody plants of which *Scutia myrtina* is the only one common to the place of observation and the study area.

Cercopithecus aethiops pygerythrus F. Cuvier, Vervet Monkey, is very common in all tree-dominated communities. Included in its locally recorded diet are the fleshy fruits of a number of trees and shrubs, and, elsewhere (approximately 15 km south of the study area), Vervet were seen to eat young leaves of *Melia azedarach*. At Isipingo Beach, Vervet Monkey were also observed pulling off flowers of *Bruguiera gymnorrhiza* for nectar. In foraging, these animals often break off or otherwise damage distal twigs of the food plants visited.

5.2.3.2.3 Carnivora

Examination of faeces of what appeared to be *Genetta rubiginosa zuluensis* Roberts, Rustyspotted Genet, showed that it had eaten some fruits as well as animals. Of the former, *Phoenix reclinata* was the only one identified.

Mungos mungo taenianotus A. Smith, Banded Mongoose, is a gregarious animal common in forest, woodland and closed scrub throughout the study area. Although carnivorous it also takes "bulbs, berries and seeds" Roberts (1951), but no feeding record was made by the author in the study area.

5.2.3.2.4 Proboscoidea

Loxodonta africana africana Blumenbach, African Elephant, has long since disappeared from this area. These herbivores were, however, "frequent in this locality", Angas (1849) referring to the Isipingo North area where they stayed in the dune forest during the day at the time of his visit (c. 1847), and where an elephant tooth was unearthed in 1961.

5.2.3.2.5 Artiodactyla

Hippopotamus amphibius capensis Desmoulins, Hippopotamus, an eater of grasses and aquatic forbs, had been exterminated in this area long before those on the Mgeni River in Durban were finally destroyed. Even in 1860 it was considered "rare in this neighbourhood nowadays" (The Natal Mercury of 23rd February, 1860, referring to one that was killed near Isipingo). Bones or teeth of this animal have been unearthed occasionally during excavations or through river-erosion in the study area.

Of the family Bovidae only two native species are still present: *Cephalophus monticola* Thunberg, Blue Duiker, and *Tragelaphus scriptus sylvaticus* Sparrman, Bushbuck. Both are forest antelope but the latter frequently moves into and feeds in more open marginal communities as well. The only feeding records of Blue Duiker obtained in the study area were of leaves of *Panicum deustum, Carpobrotus dimidiatus, Isoglossa woodii* (including distal young branches) and *Chrysanthemoides monilifera* subsp. *rotundata*. The list of plants that were eaten by Bushbuck is far more extensive and includes the leaves and young stems of grasses, forbs and woody plants, especially young saplings which were sometimes very well browsed. Because of the last mentioned it is probable that Bushbuck affect forest regeneration or succession, albeit to a limited degree in such a sparsely Bushbuck-populated area as this is today.

Although cattle are given free range in secondary grassland on the southern part of the Isipingo Flats, the effect of domestic stock in the study area as a whole is insignificant nowadays. Nevertheless domestic stock has been of local ecological importance, for example in 1959 it became necessary to take steps to remove an increasing population of goats and cattle from the Reunion Rocks area where, through trampling and feeding on colonizers of wind-blown sand, they were aggravating a serious wind erosion problem (see Fig. 10).

5.2.3.2.6 Rodentia

Various unidentified grass-eating rodents are common in grassland, particularly on the Isipingo Flats. The largest rodent is *Thryonomys swinderianus* Temminck, Cane Rat, which was formerly common in riparian grassland and was most destructive in sugar-cane fields since it fed on stems of various grasses. In Ndumu, it was recorded eating roots of *Acacia robusta* subsp. *clavigera*. However, such records have not been made for the study area in spite of the presence of both organisms. Through constant hunting and trapping, this animal is rare nowadays.

5.2.3.3 MAN

Man has had a particularly important impact on the vegetation and topography of the study area, as may be appreciated from the historical outline given in Chapter 3, and as was mentioned in Chapter 1 when dealing with both Topography and Soils.

Destruction of or damage to existing vegetation attributable to man has followed (i) utilization of plants (see below), (ii) fires (see Section 5.3), (iii) direct removal of existing vegetation for crops, houses, fuel, roads, recreational places and industry, (iv) drainage of swamps and (v) indirectly from wind erosion following removal of vegetation such as the strand pioneers and early dune scrub, although, in this regard, the oceanographic influence is of considerable importance as well.

On the other hand, protection to vegetation and topography has followed artificial stabilization of banks and river channels and, in places, exclusion of fires. Furthermore, as a result of the presence of man, alien plants and native annuals are well represented in the local flora. Recently, what appears to be faecal pollution, having its origin outside the study area, has influenced the growth of certain aquatic and stream-bank plants of the Sipingo River in the western part of the study area.

5.2.3.3.1 Utilization of native and naturalized plants

The records given here are those made only in the Isipingo Beach area and do not include data from other areas, even though the plants concerned are common to both the place of observation and to the Isipingo Beach area (this even includes edibility).

Many of the uses given here are of minor importance, or such utilization may be merely casual. On the other hand utilization of some is deliberate and carried out on a large scale as long as the product is present in suitable form or quantity, as for example the cutting of stems and leaves of *Juncus kraussii* for sleeping mats, or the gathering of plants or parts thereof for medicinal or similar use.

5.2.3.3.1.1 Plants used medicinally or in witchcraft

The effect on individual plants or on the vegetation as a whole through the gathering of such material varies considerably, for example the gathering of a few leaves of *Mirabilis jalapa* for use as a poultice (there is no wholesale use of this as such) would have little effect on the plant and even less on the vegetation as a whole. On the other hand, bark removal may be deleterious to an individual and, although the effect of such removal is usually delayed, it may lead to eventual death. Again, excavation of *Asparagus densiflorus* in the dwarf salt-spray zone, where winds are strong, results not only in the destruction of these plants, but sometimes initiates a chain of adverse reactions on the surrounding vegetation following disturbance of the cover.

The following plants (parts concerned in brackets) are used medicinally, or in witchcraft: *Gloriosa superba* (tuber), *Asparagus densiflorus* (rhizome and tubers), *Celtis africana* (bark), *Trema orientalis* (bark), *Ficus capensis* (bark), *Mirabilis jalapa* (leaves), *Carpobrotus dimidiatus* (leaves), *Albizia adianthifolia* (bark), *Erythrina lysistemon* (bark), *Fagara capensis* (bark), *Teclea gerrardii* (bark), *Clausena anisata* (bark), *Turraea floribunda* (bark of stems and roots), *Ekebergia capensis* (bark), *Trichilia dregeana* (bark), *Bridelia micrantha* (bark), *Croton sylvaticus* (bark), *Acalypha petiolaris* (roots), *Sclerocarya caffra* (bark), *Cassine papillosa* (bark), *Protorhus longifolia* (bark), *Apodytes dimidiata* subsp. *dimidiata* (bark), *Adenia gummifera* var. *gummifera* (stem), *Centella coriacea* (leaves), *Sideroxylon inerme* (bark), *Mimusops obovata* (bark), *Manilkara discolor* (bark), *Euclea natalensis* (roots), *Olea woodiana* (bark), *Carissa bispinosa* (roots), *Catharanthus roseus* (leaves), *Solanum acanthoideum* (fruit), *Solanum* sp. prob. *S. duplo-sinuatum* (fruit).

5.2.3.3.1.2 Food plants

Although this is a rather unimportant aspect of utilization by man in this area, two categories are given, namely, prepared foods and those eaten mostly raw. Into the former category fall plants which are mainly ruderals whose leaves are cooked and eaten as a green vegetable: such plants are, *Colocasia antiquorum, Chenopodium album, Amaranthus* spp. and *Tetragonia tetragonoides;* (in the case of *Colocasia antiquorum* the rhizome of cultivated plants is the main article of food). Into the second category fall those with edible fruit, such as *Phoenix reclinata, Morus* sp. cf. *M. alba, Carpobrotus dimidiatus, Rubus rigidus, Antidesma venosum, Sclerocarya caffra, Allophylus natalensis, Deinbollia oblongifolia, Scutia myrtina, Dovyalis* spp., *Opuntia vulgaris, Psidium guajava, Eugenia capensis, Syzygium cordatum, Mimusops caffra, Strychnos madagascariensis, Strychnos spinosa, Carissa macrocarpa, Physalis peruviana, Solanum nigrum, Lycopersicum* sp., *Kraussia floribunda, Vangueria infausta, Lagynias lasiantha, Canthium inerme, Chrysanthemoides monilifera* subsp. *rotundata.*

5.2.3.3.1.3 Plants used in building and fencing

Indigenous or naturalized plants of this area are not used much nowadays for anything other than for minor or temporary constructions, nevertheless a few records of such utilization in this area have been made. The plants concerned, with their use in brackets, are as follows, *Phragmites* spp. (rude huts or shelters), *Bambusa balcooa* (huts, fences), *Phoenix reclinata* (leaves for temporary roofs), *Flagellaria guineensis* (stems used for tying thatch - this plant was sometimes collected in quantity and carried out of the area for use elsewhere), *Strelitzia nicolai* (stems and leaves for temporary huts), *Erythrina lysistemon* (stems for living fence posts), *Hibiscus tiliaceus* (stems for living fence posts), *Bruguiera gymnorrhiza* (stems durable, for huts, small bridges and for other supports in water), *Sideroxylon inerme* (fence posts and boat-building), *Mimusops caffra* (fence posts). In earlier times there is little doubt that useful timber trees were cut out from accessible situations; for example, large *Avicennia marina, Albizia adianthifolia* and *Ekebergia capensis* were cut at Isipingo Beach at the turn of this century (fide H.S. Ratcliff).

5.2.3.3.1.4 Plants used for cord

In the case of these plants, the fibres are not prepared in any special way nor twisted into a rope, rather is the bark removed in strips, generally for immediate use only. Such plants are, *Acacia karroo, Hibiscus tiliaceus, Peddiea africana* and *Passerina rigida.*

5.2.3.3.1.5 Miscellaneous uses

Cutting of trees for firewood is of local importance only nowadays. In dune scrub this frequently has serious repercussions on the surrounding vegetation through increasing the effect of on-shore winds in blowing sand and in introducing salt-spray onto plants previously protected. Almost all woody plants are used for firewood. As mentioned in Chapter 3, large-scale felling of trees for fuel for the local sugar mills during the late 1850's and 1860's is likely to have caused severe disturbance to all accessible wooded communities. Within the study area, only those wooded communities in Isipingo North and on the steeper slopes of the Isipingo Beach Hill are likely to have escaped such interference.

Other plants used in this area are the following: *Digitaria macroglossa* (woven ornaments, unimportant), *Stenotaphrum secundatum* (lawns and sportsfields), *Aristida* *junciformis* subsp. *junciformis* (broom heads), *Cynodon dactylon* (lawns, sportsfields and soil stabilization). *Dactyloctenium australe* (lawns and sportsfields), *Eragrostis curvula* (soil stabilization), *Bambusa balcooa* (baskets), *Juncus kraussii* (woven traditional sleeping mats), *Strelitzia nicolai* (leaves for wrappings, such as for wrapping fish prior to cooking in open fire), *Loranthus dregei* (fruit for bird-lime), *Cannabis sativa* (illegally smoked), *Erythrina lysistemon* (ornamental), *Euphorbia tirucalli* (hedge), *Schinus terebinthifolius* (hedge), *Bruguiera gymnorrhiza* (bark for dyeing and preserving fishing nets and line), *Plumbago auriculata* (ornamental hedge), *Carissa macrocarpa* (hedge), *Cestrum laevigatum* (hedge), *Tecomaria capensis* (ornamental), *Vangueria infausta* (Blacks use distal twigs with right angled branches as porridge-strirrers and, smeared with animal fat and some protective charm, these are placed in roofs of huts as protection against lightning), *Brachylaena discolor* (sand-stabilizer, hedge and stems used in construction of crude furniture).

5.3 FIRE

The only record of fire in the local vegetation caused by lightning was that of one in a field of sugar-cane in December 1930 (The South African Sugar Journal, 1930). All other fires are probably directly attributable to man. Due to changes in land usage and to the increase in the number of roads and drains, fires are less common or at least less widespread nowadays than in earlier days.

The relatively rapid closure of the vegetation due to the increase in size and number of woody plants in the area south of the Mbokodweni River over the past three of four decades is regarded as being a direct result of a reduction in wholesale burning. Blacks who owned cattle, lived there until the early 1920's. Other cattle, used for transport on the sugar estates, grazed and were kraaled in the Mbokodweni valley until the 1940's. As long as cattle were in the area fires would have been set into the grassland to provide green fodder. With the removal of cattle, fires were far less frequent and the plant succession has been permitted to proceed towards mesic wooded communities. The construction of the main South Coast road (Kingsway) in the 1930's would have reduced the spread of fire from the Mbokodweni Valley to the upper Athlone Park hill and vice versa. With the later construction of a golf course (opened in 1945) in this valley, the chance of fires was further very considerably reduced. Currently the vegetation of this section contains a number of relics of open communities, tolerant of fire, such as *Sclerocarya caffra* or, more rarely, *Acacia sieberana* var. *woodii* as well as a larger number of more mesic coast forest precursors and initials.

Deliberate fires introduced in the dry season into the secondary grassland and open scrub on the Isipingo Flats adjacent to a Road Party Camp to reduce the danger of accidental fires to this camp have tended to halt succession in the open stages. Closure of these open communities, however, is often accelerated after removal of fire as a regular factor since many of the invaders are not killed completely by fire and they often shoot with more stems than ever after having been burnt. Such regeneration is restricted by repeated fires and with competition from grasses, as is well exhibited when edaphic factors do not favour rapid invasion by woody plants.

The ability to withstand fires or to be able to regenerate rapidly after burning is well exhibited by the majority of indigenous forest marginal plants as well as by the alien, *Lantana camara*. These plants form very effective protective barriers against grass fires in a number of places where forest or woodland occurs. Such places previously also included the white sand dunes of Isipingo North where, prior to recent and current destruction, forest margins were encroaching onto the open grassed areas particularly where aided by good drainage, reduced insolation and on-shore breezes. Such situations appeared to have been unsuitable for the taller fire-supporting grasses. Fires, however, still occurred in the shorter grasses, but these had only a moderate or very temporarily halting effect on most of the invaders. An exception was *Passerina rigida* since this species is readily killed by fire.

A removal of the marginal barrier plants enables fire to penetrate into the fringes of the less fire-tolerant forest or closed woodland. Thus, by favouring the development of the more fire-tolerant heliophilous grasses, forbs and shrubs, plant succession is set back. Such retrogression is very limited nowadays and is associated only with isolated. generally small, fires.

Casual fires set into vegetation on the seaward slopes of the main hills have had more serious consequences since this evergreen vegetation is not naturally subjected to fires. This is particularly the case where *Strelitzia nicolai* is an important constituent of the vegetation because older specimens of *S. nicolai* provide much inflammable material and the subordinate strata, in response to the dense shade cast by this species on well-drained sandy substrates, are poorly developed. After a fire, the cover is greatly reduced and, in spite of the porosity of the soil, there is often local soil erosion. Fortunately, from the point of view of erosion, regeneration from the base of the majority of the burnt plants takes place and there is generally an invasion by quick-growing herbaceous plants where not trampled by man. Thus the soil is soon re-covered on the moister slopes, but more slowly so on the drier slopes. However, from the plant successional point of view, degradation follows such fires, since, in addition to possible soil disturbance prior to the re-establishment of a good cover, the vegetation is generally markedly changed. The original taller plants are killed above either directly by the fire or indirectly through being subjected to increased salt-spray, following the destruction of the windward protectors. Not only are the exposed shoots killed by increased amounts of salt-spray, but also regeneration is prevented other than where the new shoots are protected from the strong on-shore winds. This leads to an opening of former closed communities, an increase in the number of herbs and a lowering of the height of the canopy.

Fires in mesic grassland following the halosere or in late hydrosere have had serious local effects on the invading trees since many of these, whilst tolerant of factors associated with moist low-lying situations, do not tolerate fire. These trees are killed or, regenerating only slowly after having been burnt, they become even more susceptible to repeated fires and to more direct competition with the grasses. Therefore, under these circumstances, fire halts succession and, depending upon other environmental conditions, maintains grassland, open scrub or thicket communities. Protection from fire permits plant succession to proceed via scrub, or thicket, and woodland to forest.

Mangroves are killed by fire. Therefore fire prevents mangroves from invading low-lying herbaceous vegetation (generally grass-dominated, if it supported a fire in the first place) or *Phragmites australis* consocies. Furthermore, where fire kills the peripheral trees of a mangrove stand, shade is reduced. This permits invasion by salt-tolerant heliophytes or, if the soil level has been built up above tidal influence, by other plants as well. Thus, where changes in edaphic factors permit, succession from a halosere to a mesosere is accelerated by fire, albeit to open communities which, in the absence of fire, but with similar changes in edaphic factors, may have been by-passed in the general succession to mesic forest.

To summarize, the effect of fires in the Isipingo Beach area has been to encourage the development of grass-dominated or open communities at the expense of forest trees. This has been achieved by retrogression from formerly closed wooded communities, by halting succession in a grassland stage (particularly where fire is aided by factors favouring the development of grasses) or by slowing down secondary scrub succession in open disturbed places. With increasing subdivision of the land and with changes in agricultural practices or land usage in general, burning of the vegetation has been reduced considerably. Nowadays, fires are only isolated, small and incidental with the exception of those used as fire breaks in the vicinity of the Road Party Camp on the Isipingo Flats. This protection from fire is reflected in the rapid succession towards forest that is taking place throughout the study area where other environmental factors permit. This is particularly well shown in places on the Isipingo Flats and south of the Mbokodweni River in general.

CHAPTER 6

Annotated check-list of vascular plants from the Isipingo Beach area

This list of vascular plants, collected within the mapped area shown in Figs 1 and 59*, has been made as comprehensive as possible particularly because much disturbance or destruction is taking place as a result of industrial development and general expansion. For a similar reason various data, gleaned only from observations in the field, have been included as a contribution to the autecology of the listed plants.

With the exception of a few which occur as relicts or have established themselves where discarded by man in feral vegetation, aliens, deliberately planted, have been omitted. Naturalized aliens, on the other hand, are treated as members of the established flora of the Isipingo Beach area.

All plants mentioned are represented by herbarium specimens which are housed in the herbarium of the University of Natal in Pietermaritzburg. Duplicates of most have been sent to the Botanical Research Institute, Pretoria, and to the Natal Herbarium which also has the only specimen of *Tridactyle bicaudata*. Duplicates of numbers subsequent to *Ward* 4 600 are housed also in the herbarium of the University of Durban-Westville. The numbers given under each plant represent the author's collecting numbers.

The arrangement of the families and genera in this check-list follows Schelpe (1969) for the Pteridophyta and, for the Spermatophyta, Phillips (1951) which is based on De Dalla Torre & Harms (1900 to 1907); however, where applicable, generic names and family names and delimitations are those given in Flora of Southern Africa Vol. 1 (Codd, De Winter & Rycroft, 1966) and Vol. 13 (Codd, De Winter, Killick & Rycroft, 1970), Ross (1972) or/and Dyer (1975, 1976). Species are given merely in alphabetical order throughout.

Information is given, where known, for each plant concerning: life span (mainly of herbs or annual plants), growth form, size (included as a measure of performance within this area, directly taped or measured with an instrument), habitat (see note below), frequency (a subjective estimate, nevertheless one based on intimate association with the area over a number of years), phenology of leaf production and fall (where applicable), times of flowering and maturation of fruit (if there is much delay between these times or if maturation of fruit has some special significance), biotic factors and, finally, utilization by man.

Standard terminolgy for habitat as suggested at the 1956 Yangambi Conference (Boughey, 1957) has been adhered to wherever possible but, in such a small area as the one under discussion, it has been necessary to include other subdivisions which, it is considered, are self-explanatory. However, "woodland-forest" has been used to denote a condition too complex for "woodland" and not yet sufficiently dense or stratified to satisfy the definition of "forest" (such a habitat is well represented in this area where an interfering factor, such as fire, has ceased to be of major ecological importance in certain places for many years and succession has been allowed to move from scrub or woodland to forest).

It is emphasized that the data contained herein are applicable to the mapped area and, with the exception of individually acknowledged items, are all the author's personal observations and do not represent a summary of all known data. The above-mentioned exceptions are a few records (seventeen in all) concerning feeding records of animals made by colleagues and given verbally to the author, mostly in exchange for botanical identification. Such records are individually acknowledged in the relevant sections.

Phenological data have been supplemented from records made from neighbouring areas where conditions are considered to be similar to those encountered in the mapped area. Main months are given directly, with less important months given in brackets to indicate the full range of the phenomenon as observed. Flowering times of annuals have been included although this may be variable depending upon the severity of adverse factors: several summer-flowering annuals may germinate and flower during the winter months if this period is mild and rains occur.

Biological data, likewise, are given for this particular area, but observations have been included from elsewhere when the author is satisfied that either the organisms concerned are common to both the place of observation and to the Isipingo Beach area or, as particularly in the case of insects, the group is represented by similar members in both places. For simplicity, any such information which may have been gleaned from outside the mapped area merely has the word "elsewhere" added to it. "Elsewhere" may be within the immediate neighbourhood, or as far afield as Zululand, or the lower Natal south coast. Where an actual feeding record of fruit or seed has not been made, but where seedlings of fruit-bearing plants have been observed growing beneath trees known to be visited by frugivorous birds (or fruit bats) such records are included with a cautionary "apparently" added to the data.

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* Fig. 59 inside back cover

The use of the plural in regard to the common names of animals indicates that more than one species and not more than one individual of the particular group is involved. Names of hosts of parasitic plants are included only if that particular relationship has been recorded within the mapped area; many host/parasite records are thus excluded, even though both host and parasite may occur in the Isipingo Beach area. See also Chapter 5 for Biotic Factors and for the scientific names of the birds and mammals mentioned in this section.

Because of variation in use of plants by man (particularly medicinal use), records from wider afield are not included; likewise, because of the lack of local confirmation, the acutal use is seldom given, although man's effect on individual plants such as "bark removed" or "roots dug up", is included where applicable.

PTERIDOPHYTA

EQUISETACEAE

Equisetum ramosissimum Desf.
Stem herbaceous, erect, up to approximately 120 cm tall but in riparian scrub may be somewhat scandent with stems up to 250 cm long; rhizome elongated; generally in low-lying sandy soils, often pioneering disturbed places; very common; fertile cones January to May 293, 6175

OPHIOGLOSSACEAE

Ophioglossum polyphyllum A. Braun ex Seubert
In open short grassland, sandy soils; abundant; readily regenerates after grassfires, barren fronds appear within few days of fire; fertile spikes mature late September to July 295, 4841, 5331

Ophioglossum sp.
In low-lying places in grassland, clayey soils; locally common; fertile spikes mature February to April 4844, 5328

SALVINIACEAE

Salvinia molesta D.S. Mitchell
Free-floating in drain from reed-swamp on north-eastern part of Isipingo Flats; locally abundant, apparently established only since 1967, at least in mapped area; sporocarps November to March 6734

DENNSTAEDTIACEAE

Pteridium aquilinum (L.) Kuhn
Rhizome elongated; fronds up to 290 cm long where competition considerable, generally shorter; in scrub near Sipingo River, sandy soil; locally frequent; sori February to July 897

ADIANTACEAE

Acrostichum aureum L.
Rhizome compacted; fronds erect up to 230 cm long where shaded; in clumps marginal to and just within upper fringe of mangroves; very localized, habitat recently totally destroyed; sori October to July 3739

Pityrogramma calomelanos (Sw.) Link var. *aureoflava* (Hook.) Weath ex Bailey
Rhizome compacted; fronds erect up to 74 cm long; on almost vertical bank of cutting, in red sandy clay, south-facing; locally frequent; sori January 5287

Pteris catoptera Kunze
Rhizome compacted; fronds up to 145 cm long; in shade in woodland, red slightly clayey sand on steep mesocline of Jeffels' Hill; rare; sori February to April 5310

Doryopteris concolor (Langsd. & Fisch.) Kuhn var. *kirkii* (Hook.) Fries
Rhizome compacted; in complete shade in woodland-forest, low-lying area; locally frequent; sori March to May, October 515

Pellaea viridis (Forsk.) Prantl
Rhizome compacted; fronds up to 76 cm long; in open grassland or in partial or complete light shade in scrub and woodland, in low-lying sandy alluvial soils; common; sori September to July 1283

POLYPODIACEAE

Phymatodes scolopendria (Burm. f.) Ching [=*Polypodium scolopendria* Burm. f.]
Rhizome shallow, often exposed, much elongated; fronds erect, up to 75 cm long; terrestrial, pseudo-epiphytic or, less commonly, truly epiphytic in maritime scrub and woodland and in low-lying somewhat moist woodland-forest on well-drained soils, abundant; also rare as lithophyte in crevice in supralittoral rocks; sori September to July 52, 53, 6292

Microgramma lycopodioides (L.) Copel. [=*Polypodium lycopodioides* L.]
Rhizome elongated, sometimes somewhat matted; pseudo-epiphyte or true epiphyte in riparian short woodland-forest; locally common (habitat recently destroyed); sori in all months 400

Phlebodium aureum (L.) J. Sm.
Rhizome elongated; epiphyte 4,5 to 5 m up on stem of *Phoenix reclinata* Jacq. in partial light shade at woodland margin of small swamp; rare 1249

Microsorium punctatum (L.) Copel. [=*Polypodium polycarpon* Cav.]
Rhizome short, with numerous rootlets; fronds up to 120 cm long x 10 cm wide; nest-epiphyte up to 6 m above ground, generally lower, or occasionally in clumps on ground in shade, in dune forest and low-lying woodland-forest; common; sori October to July 54, 611

DAVALLIACEAE

Nephrolepis cordifolia (L.) Presl
Rhizome compacted with tuberous runners, forming dense mass amongst leaf bases at apex of stems of *Phoenix reclinata* Jacq., currently 6-9 m above ground, in low-lying woodland-forest, locally frequent; sori December to February.......................... 6291, 6313, 6712

ASPLENIACEAE

Asplenium prionitis Kunze
Rhizome compacted; fronds up to approximately 100 cm long; in deep shade in dune forest; common; sori all months 504

THELYPTERIDACEAE

Thelypteris dentata (Forsk.) E. St. John [=*Dryopteris dentata* (Forsk.) C. Chr.]
Rhizome shortly creeping, in somewhat moist shaded places; locally frequent; sori December to April 1268

T. totta (Thunb.) Schelpe [=*Dryopteris gongylodes* (Schk.) O. Kuntze]
Rhizome elongated; in moist places, particularly marginal to reed-swamp; locally abundant; sori February to July..601

SPERMATOPHYTA

GYMNOSPERMAE

PODOCARPACEAE

Podocarpus latifolius (Thunb.) R. Br. ex Mirb.
Tree up to 12,5 m tall (stem 56 cm d.b.h.) and up to 61 cm d.b.h. (tree 10,7 m tall); in dune forest; common; cones May, October, December, mature, elsewhere, April, July, November, eaten by birds; timber not used locally 354, 612, 861, 1192

ANGIOSPERMAE

TYPHACEAE

Typha latifolia L. subsp. *capensis* Rohrb.
Herb with elongated rhizome, flowering stem up to 220 cm tall; on sandy stream banks and in shallow permanent water, often associated with *Phragmites australis* and tall sedges; very common; flowers February, May, July, October to November (to December); fruit dispersed late December to March (to June) 619

ZOSTERACEAE

Zostera capensis Setchell
Rhizome creeping; submerged, rooted in mud in tidal estuary, temporarily blocked at time of collection, very localized and not seen again since collected (September, 1948); fertile September, elsewhere June to November 495

POTAMOGETONACEAE

Potamogeton crispus L.
Rhizome creeping; submerged, in flowing fresh water; locally common; flowers September 384, 472

P. pusillus L.
Rhizome creeping, branched; submerged, in flowing water in drain from reed swamp; locally very common; flowers March to April 1255

JUNCAGINACEAE

Triglochin bulbosa L.
Perennial herb, rhizome sympodial, elongated, ramifying, aerial shoot acaulescent, fibrous tunics poorly developed, leaves clasping below terete acicular above, inflorescence erect 30-75 cm tall, slightly longer than leaves; in mud flats adjacent to tidal lagoon and estuary, generally inundated only at exceptionally high tides; common; flowers in all months 274, 917, 6760

T. striata Ruiz & Pav.
Perennial herb, rhizome sympodial, elongated, ramifying, aerial shoot acaulescent, leaves clasping below, half-rounded adaxially flattened to ligulate above, inflorescence erect 12-47 cm tall, slightly longer than leaves; in sandy mud of upper intertidal banks in estuary; very common; flowers in all months 145, 264, 918, 919, 6759

POACEAE (GRAMINEAE)

Imperata cylindrica (L.) Beauv.
Perennial, rhizome elongated, well developed, often deep; important member of early mesosere following hydrosere or halosere, in sand or clayey sand, also in disturbed open areas; abundant; flowers July to April, one of first to flower after fire, especially if rain follows fire or if in moist-mesic situations; flowers often with pungent scent; one of several hosts of *Thesium asterias* A.W. Hill in Isipingo North grassland 573

Miscanthidium capense (Nees) Stapf
Tufted, robust perennial, culms up to 210 cm tall; in low-lying grassland and open scrub; common; flowers January to April (to June) 1276

Ischaemum arcuatum (Nees) Stapf
Perennial, rhizome creeping; in moist non-saline places, sometimes lightly shaded; common; flowers October to April 752, 850

Hemarthria altissima (Poir.) Stapf & C.E. Hubb.
Perennial, rhizome creeping, sometimes loosely tufted, culms weak sometimes rooting below; in moist places, slightly brackish or, more generally, freshwater; common; flowers September to May 750

Rottboellia exaltata L.f.
Tufted annual, culms up to 46 cm tall; in formerly cultivated low-lying area, in loam; rare; flowers February to May 5355

Andropogon eucomus Nees
Tufted perennial, culms up to 75 cm tall; in open grassland, particularly low-lying areas, sandy soil, generally where formerly disturbed; common; flowers September to April; plumose infructescences until June 1275

Sorghum verticilliflorum (Steud.) Stapf
Tufted, apparently annual, culms up to 200 cm tall, in moist places, particularly where disturbed; clayey or loamy sands; common; flowers and fruit in all months, least in July - early August; elsewhere flowers visited by pollen-eating Syrphidae (Diptera), and other insects when fungus-infested; fruit eaten by birds (i.a. Yellow-eyed Canary) 336, 6302

Bothriochloa glabra (Roxb.) A. Camus
Perennial, tufted, robust, culms up to 80 cm tall; in *Imperata*-grassland on flood-plain of former Mlazi River and neighbouring disturbed area; slightly loamy sand; locally frequent; flowers January to April 6548

B. insculpta (Hochst.) A. Camus
Perennial, tufted, sometimes loosely so, culms erect up to 135 cm tall and outer culms decumbent, up to 200 cm long, rooting infrequently below; at long-undisturbed roadside, in well-drained sandy soil with stones on north-facing slope above Mbokodweni River; locally frequent; flowers October to June (to July) 6669

Cymbopogon excavatus (Hochst.) Stapf ex Burtt-Davy
Perennial, tufted, culms up to c. 90 cm tall; invader of short grassland; abundant; flowers February to April 760, 4843

C. validus (Stapf) Stapf ex Burtt-Davy
Perennial, tufted, robust, culms up to 260 cm tall; seral between hygrophilous grassland and scrub or woodland; common, dominant in riparian grassland; flowers January to May 306, 1284, 4845

Hyparrhenia dichroa (Steud.) Stapf
Perennial, tufted, culms up to 340 cm tall, in open secondary vegetation and on roadsides; locally common on north-facing slope above Mbokodweni River; flowers (October to) March to May (to July) 3742, 6213

H. filipendula (Hochst.) Stapf var. *pilosa* (Hochst.) Stapf
Perennial, tufted, culms up to 127 cm tall, generally somewhat

less; in open mixed grassland; sandy soils; abundant, also locally frequent roadside ruderal; flowers (August to) October to May. Apparently occupying same ecological niche as the following from which it is difficult to separate especially when sterile. (See note below) ... 3743, 3772, 5360

H. sp. cf. *H. hirta* (L.) Stapf
Growth form as above but up to 90 cm tall; in open mixed grassland away from direct maritime influence; very common throughout; flowers (July, on recent burn to) October to April (to May). Difficult to separate from *H. filipendula* (Hochst.) Stapf var. *pilosa* (Hochst.) Stapf (above); possibly all form part of a hybrid complex between *H. hirta* and *H. filipendula* ... 1266, 5002, 5359

Heteropogon contortus (L.) Beauv. ex Roem. & Schult.
Tufted perennial, culms 15-50 cm tall; in open mixed grassland, sandy soil; common; flowers September to December (to February) ... 991

Tragus berteronianus Schult.
Annual, tufted and culms decumbent, rooting from lower nodes, up to 40 cm tall; in disturbed low-lying sandy soil; frequent; flowers (September to) October to March; fruits externally distributed by animals. Elsewhere culm and rachis infested by aphid, in turn attended by ant (*Plagiolepis custodiens*) which walk over flowers ... 6163

Perotis patens Gand.
Annual, sometimes perennial with compacted rhizome, culms slender erect or ascending 40-75 cm tall; in open grassland and open scrub, sandy soil; common all over; flowers (July to) October to May ... 983

Paspalum dilatatum Poir.
Tufted, perennial, culms up to 80 cm tall; in moist places, generally where disturbed; frequent; flowers November to March ... 1232

P. notatum Flügge
Perennial, rhizome shortly creeping, robust, shallow, generally partially exposed; in hard stony soil at roadside; frequent; flowers December to March ... 1365

P. paspalodes (Michx.) Scribn.
Perennial, stoloniferous, occasionally rhizomatous as well; in sand or loam in low-lying moist areas, particularly stream banks; abundant; flowers December to May. Frequently parasitized by *Claviceps* sp., in turn parasitized by other fungi or the latter saprophytic on honey dew; honey dew and/or secondary fungi insect visited ... 1278, 1315, 1358, 5258, 5259, 5277

P. scrobiculatum L.
Tufted, perennial, sometimes apparently annual, culms 15-70 cm tall; in moist places, open grassland or in partial shade; often where disturbed; common; flowers November to June ... 1323, 1366

P. urvillei Steud.
Perennial, tufted, robust, culm up to 200 cm tall; on stream banks or disturbed areas adjacent to swamps; common; flowers (July to) August to April (to June), elsewhere visited by pollen-eating Syrphidae (Diptera); occasionally parasitized by *Claviceps* sp.; fruit eaten by birds (i.a. Red Bishop Bird) ... 1321, 1359, 4653

P. vaginatum Swartz
Perennial, stoloniferous, occasionally partly rhizomatous as well; in saline mud and sandy soils of lagoon at upper limit of ordinary spring tides and slightly higher; also in shallow sandy soil on rocks in supralittoral salt-spray zone; abundant; flowers late December to April ... 271, 876, 5251, 5262, 5265, 5276

Pseudechinolaena polystachya (H.B.K.) Stapf
Slender perennial, culms decumbent, rooting from lower nodes; in light shade in riparian woodland; common; flowers March - June, (August) ... 849, 6233, 7142

Panicum chusqueoides Hack.
Perennial, sometimes loosely tufted, mostly with culms weak, spreading, somewhat rambling, rooted from lower nodes; marginal to and within woodland and early forest, especially where disturbed; common; flowers October to April ... 768, 3750, 4910, 5292, 5314

P. deustum Thunb.
Perennial, tufted, culms erect to 120 cm tall, or culms somewhat trailing in salt-spray zone; in sun or light shade all over - salt-spray zone, dune forest and in river bank scrub and woodland; very common; flowers (July to) August to May (to June), visited by small bees (for pollen); eaten by game and stock ... 250, 869, 911, 1376, 5296, 6164

P. hymeniochilum Nees var. *glandulosum* Nees
Perennial, shortly rhizomatous, culms weak, rambling, rooted below; in marsh, with hygrophilous herbs, partially lightly shaded; very locally frequent; flowers January to July ... 6758

P. laticomum Nees
Culms weak, branched, rooting from lower nodes; in shade in short forest on xerocline of main hills and in low-lying places; frequent; flowers February to April .. 4877, 4916

P. maximum Jacq.
Perennial, tufted, culms to 200 cm tall; heliophyte or facultative sciophyte, common all over, often occurring in disturbed places; flowers and fruit in all months especially September to April; often smut-infested; flowers visited by small grey bee (for pollen) and elsewhere by pollen-eating Syrphidae as well as other flies when parasitized by *Claviceps* sp. or other fungi associated with *Claviceps* sp.; fruits eaten by several granivorous birds; plant eaten by most grazing animals and elsewhere by cane-rat ... 1279

P. subalbidum Kunth [=*P. glabrescens* Steud.]
Apparently annual or perennial, tufted, culms often partly decumbent or geniculately ascending, 40-150 cm tall; on open river banks and in disturbed low-lying places, sandy soils; common; flowers (July to) September to May; fruit eaten by Bronze Mannikin ... 845, 1254, 1319, 1333, 1356, 1361

Brachiaria arrecta (Hack. ex Dur. & Schinz) Stent
Perennial, rhizome short, culms ascending, up to 90 cm tall; rooting below; in moist areas, marginal to reed-swamp and on river banks, locally abundant; flowers December to April ... 1263, 5343

Echinochloa colona (L.) Link
Annual, tufted, culms 10-100 cm tall; in disturbed areas, often moist places, also roadside ruderal; common; flowers September to May ... 473, 1300, 4860, 6048, 6203

E. cruspavonis (H.B.K.) Schult.
Annual, tufted, culms up to 250 cm tall; in moist places, stream banks or near reed-swamp, sometimes in light shade; common; flowers (December to) January to May ... 1264, 1314, 1330, 6201, 6205

Sacciolepis curvata (L.) Chase
Perennial, loosely tufted, culms mostly decumbent or semi-trailing, rooting from lower nodes; in open grassland and with taller grasses in open scrub, sandy soils; common; flowers August to June ... 982

Digitaria adscendens (H.B.K.) Henr.
Annual, tufted and outer culms decumbent, rooting below, often for some considerable length so as to appear stoloniferous, erect part up to 90 cm tall; ruderal in clayey sand on Isipingo Flats; very common; flowers January to March (to May); fruit eaten by Bronze Mannikin ... 1299, 5347

D. debilis (Desf.) Willd.
Annual, loosely tufted and culms decumbent, rooting from lower nodes, up to 60 cm tall; on sandy bank of river, frequent; flowers September to April 1277

D. diversinervis (Nees) Stapf
Perennial, stoloniferous, or semi-trailing, erect culms up to 55 cm tall; marginal to or within light woodland-forest; common; flowers February to May (to July where disturbed), visited by small bee for pollen 137, 304

D. longiflora (Retz.) Pers.
Perennial, stoloniferous, erect culms up to 40 cm tall; in open grassland, sandy soil, frequent; flowers November to May 1328

D. macroglossa Henr.
Perennial, tufted, culms up to 140 cm tall; seral between short grass stage and scrub, very common; flowers October to May, visited by small beetle; culms used for woven ornaments 331, 4962

D. sanguinalis (L.) Scop.
Annual, culms decumbent, rooting from lower nodes, up to 75 cm tall; ruderal, sandy soils; common; flowers January to March, visited by small bee for pollen 786, 789

D. scalarum (Schweinf.) Chiov.
Perennial, rhizomatous sometimes very shortly so, culms up to 40 cm tall; in open secondary grassland, sandy soil, also in disturbed places; common, in places abundant; flowers in all months, least in July 1285, 1327, 4654

D. smutsii Stent
Perennial, tufted, culms up to 150 cm tall; in open scrub with other grasses and forbs, coarse sandy soil in Mbokodweni valley; common; apparently filling locally same ecological niche as *D. macroglossa* Henr. (Ward 4962); flowers January to May 4835

D. ternata (A. Rich.) Stapf
Annual, tufted, culms up to 90 cm tall; ruderal in low-lying canefields, in loam; common; flowers October to March 1305, 5345, 5346

Acroceras macrum Stapf
Perennial, shortly rhizomatous, culm geniculately ascending, up to 75 cm tall; in moist soil at edge of small vlei; frequent; flowers October to March 1213

Tricholaena monachne (Trin.) Stapf & C.E. Hubb.
Perennial, tufted, culms up to 100 cm tall; in secondary grassland and open scrub on Isipingo Flats, sandy soil; occasional; flowers December to April 5329

Rhynchelytrum repens (Willd.) C.E. Hubb.
Apparently annual or perennial, tufted, erect or ascending, culms often rooted below, up to c. 80 cm tall; open areas, sandy soils; very common; flowers and fruits all months, chiefly September to June; elsewhere fruits eaten by granivorous birds, i.a. Bronze Mannikin (teste K.L. Tinley) 303

Oplismenus hirtellus (L.) Beauv.
Perennial, culms decumbent, rooting freely below, flowering culms erect, up to 60 cm tall; in shade in riparian woodland; frequent; flowers and fruits February to May; fruits externally distributed by animals, sometimes viscid especially when humidity high 307, 6235

Setaria chevalieri Stapf ex Stapf & C.E. Hubb.
Robust perennial, tufted, culms up to 200 cm tall; in woodland, mostly marginal, in low-lying areas; common; flowers November to April 782

S. pallide-fusca (Schumach.) Stapf & C.E. Hubb.
Annual, tufted, culms erect or ascending, rooting below, up to 125 cm long; in canefields, Isipingo Flats; common; flowers January to April (to May) 5348, 6049

S. sphacelata (Schumach.) Stapf & C.E. Hubb. ex M.B. Moss
Perennial, tufted, c. 100 cm tall; in open mixed grassland, sandy soil; very common; flowers (August to) September to April (to June), elsewhere visited by small bee for pollen 994, 3776

S. verticillata (L.) Beauv.
Annual, loosely tufted, culms sometimes rooting from lower nodes, generally leaning; in disturbed low-lying areas; frequent; flowers December to April; fruits externally distributed by animals 4966

Cenchrus brownii Roem. & Schult.
Annual, tufted, culms 20-60 cm tall, sometimes geniculately ascending, rooting occasionally below; in disturbed sandy soil; common, particularly in Isipingo North; flowers and fruit August to May, visited by small beetle; fruits externally distributed by animals 762, 4842, 6730

Pennisetum purpureum Schumach.
Robust perennial, rhizome abbreviated forming large clumps, culms up to 460 cm tall; in open communities on bank and flood-plain of Mbokodweni River; frequent, occasional elsewhere where planted; flowers late May to August, visited by 5 spp. Diptera (including pollen-eating Syrphidae), small beetles and thrips, (these include records from outside of mapped area); elsewhere fruit eaten by Bronze Mannikin; useful for combating erosion 5820

Stenotaphrum secundatum (Walt.) Kuntze
Perennial, stoloniferous; in low-lying, generally moist places, usually in slightly saline soils; abundant, in parts forming pure stands e.g. between true halophytes and mesic vegetation; also in open parts in salt-spray zone at base of seaward-facing hills; common; flowers September to May (to July), elsewhere visited by small black bees for pollen, in addition possibly for some exudate; one of hosts of *Cuscuta campestris*; useful lawn grass 325

Leersia hexandra Swartz
Perennial, rhizomatous and stems trailing, rooting from lower nodes; in moist places or in water at edges of swamps and rivers, often trailing in upper layers of water; very common, in parts locally dominant; flowers and fruit December to May (to June); fruit eaten by duck and teal (teste K. Cooper) 835, 1324, 1355, 6736

Ehrharta calycina J.E. Sm.
Perennial, tufted, 60-80 cm tall; in open mixed grassland, sandy soil; very common; flowers mid-September to November 548

E. erecta Lam. var. *natalensis* Stapf
Perennial, tufted, culms erect up to 45 cm tall, sometimes decumbent rooting from lower nodes; in light shade or in open areas in woodland or in dwarf salt-spray zone where generally represented by somewhat procumbent growth from; very common; flowers October to May (to July) 533, 4984

Aristida junciformis Trin. & Rupr. subsp. *junciformis*
Perennial, tufted, up to approximately 75 cm tall; in open grassland and open scrub; common; flowers February to April; fruits March to June, dispersal aided by animals (externally); culms used for brooms 4963

Sporobolus africanus (Poir.) Robyns & Tournay
Perennial, tufted, up to 150 cm tall; in open secondary grassland and in disturbed places; common; flowers August to April 1367

S. fimbriatus Nees
Perennial, tufted, up to 140 cm tall; in open scrub and grassland, pale sandy soils, well-drained; common; flowers February to May 6521

S. virginicus (L.) Kunth
Perennial, rhizomatous, sometimes somewhat tufted as well, occasionally culms decumbent, rooting below; heliophyte, very common in saline soils at or just above high water ordinary spring tide in lagoon, in dwarf salt-spray zone at base of seaward-facing hills or on supralittoral rock platform and in fixed beach dunes; also in open short grassland on well drained soils where subjected to on-shore winds; flowers November to February (to March), fruits until May .. 1272, 1280, 1313, 5250, 5261

Polypogon monspeliensis Desf.
Annual, tufted, culms up to 50 cm tall; ruderal, in sand and clayey sand, moist places; frequent; flowers September to January 518, 1215, 6817

Agrostis lachnantha Nees
Perennial, loosely tufted, culms slender up to 100 cm tall; in moist soil on river bank; frequent; flowers December to January 1317, 6293, 6314

Avena sativa L.
Annual, tufted; ruderal in open short grassland adjacent to old camp; localized, occasional; flowers November to December 3768

Cynodon dactylon (L.) Pers.
Perennial, rhizomatous, sometimes stoloniferous as well; in open grassland and open scrub, sandy soils; common throughout, particularly abundant in aggressive, rhizomatous, and rambling to semi-scandent (up to 200 cm above ground) form along flood-plain of Mbokodweni River and adjacent alluvial flats, where disturbed; flowers all months, chiefly December to February; eaten by stock, especially robust form, and elsewhere young laminae and soft culm eaten by Bronze Mannikin; used for lawns, sportsfields and for combating erosion 878, 5316

Chloris gayana Kunth
Perennial, tufted or sometimes shortly stoloniferous as well, culms up to 90 cm tall; in open grassland and open scrub; common; flowers November to May 313

C. pycnothrix Trin.
Annual, tufted and culms decumbent, up to 40 cm tall; in disturbed places, often low-lying; very common; flowers in all months, chiefly October to June (to July); fruit eaten by Bronze Mannikin (teste K.L. Tinley) elsewhere 886, 6605

C. virgata Swartz
Annual, tufted and shortly stoloniferous (rooting from decumbent stems), culms up to 90 cm tall; in disturbed places, sandy soils; occasional, recorded only from Isipingo North; flowers January to April 6581

Eleusine indica (L.) Gaertn.
(This may include *E. indica* (L.) Gaertn. subsp. *africana* (Kennedy-O'Byrne) S. Phill. as well)
Tufted, annual or short-lived perennial, culms to 60 cm tall; in disturbed soils, common ruderal; flowers September to May; elsewhere inflorescence visited by Syrphidae in morning and evening, apparently for some exudate; fruit eaten by birds, i.a. Bronze Mannikin, elsewhere, (teste J.M. Feely); plants eaten by various mammals .. 332, 6230

Dactyloctenium australe Steud.
Perennial, stoloniferous, erect branches up to 50 cm tall, may be taller where shaded; in light shade or in open grassland, sandy soils, very common all over, extending into salt-spray zone (where somewhat protected) at base of seaward-facing hills; flowers (November to) December to April (to May), elsewhere flowers visited by bees for pollen; used for lawns and sportsfields 315

D. geminatum Hack.
Perennial, stoloniferous, erect branches up to 76 cm tall; in slightly clayey sand, riparian grassland (just above extreme tidal level); locally common; flowers December to April 5260

Arundo donax L.
Robust perennial, rhizome elongated, culms up to 770 cm tall; just within margin of short woodland-forest and on refuse dump; localized; flowers March to April 739

Phragmites australis (Cav.) Trin. ex Steud.[= *P. communis* Trin.]
Robust perennial, rhizome elongated, horizontal or vertical; horizontal rhizome generally dorso-ventrally flattened, white, may flex upwards to form photosynthetic knee above ground, roots radiate in all directions from subterranean nodes but only descend from nodes on or close to surface; when colonizing bare places, terrestrial or aquatic, generally with elongated horizontal stem, up to 11 m long, bearing modified leaves with much reduced laminae, distally ascending with ordinary vegetative leaves, upright culms or descending rhizomes produced at some or all nodes along whole horizontal length of such stems; flowering culm erect, axillary from rhizome or horizontal stem or terminal as upright extension of horizontal and vertical rhizome, seldom branched, relatively slender, only slightly terete, up to 450 cm tall (11 mm maximum internode diameter at 150 cm above substrate), much shorter (may be only 70 cm tall) and more slender where soil drainage impeded or when arising from new horizontal parts peripheral to stand; leaf-sheaths persistent, overlapping on upright culms; in swamps, other moist places with restricted drainage or in standing water, extending into intertidal estuarine areas where salt water diluted by influx of fresh water, nevertheless tolerant of salinities up to 31‰ (at least temporarily), in organically rich sand, clayey sand and mud; abundant, in parts dominant or forming pure stands; laminae of leaves on flowering culms become dry and fall as flowers (and fruit) produced; flowers March to May (to July); fruit dispersed April to June (to July); after fruiting, culms die back generally to ground level or to branches if present; aerial parts eaten by various mammals and, elsewhere, rhizomes dug up by Bush Pig and early new shoots eaten by Purple Gallinule; used in hut building 6550, 6551, 6583, 6585, 6592, 6594, 6595, 6596, 6597, 6598

P. mauritianus Kunth
Growth form, rhizomes, roots and stems as described for *P. australis*, with the following exceptions:
(i) no elongated horizontal stem above ground,
(ii) all parts more robust than *P. australis*,
(iii) erect culms often well branched,
(iv) culms naked at least in mid-section (sheaths of ordinary vegetative leaves fall with laminae),
(v) may be up to 584 cm tall (21,5 mm internode diameter at 150 cm above ground),
(vi) erect culms more noticeably terete,
(vii) apices of laminae of earlier leaves, especially on side branches, markedly pungent and
(viii) able to be observed only in winter and spring, the non-deciduous laminae on flowering culms (see below).

In generally well-drained sandy soils, along river banks, on flood-plains or in other somewhat moist situations, sometimes well away from visible or near-surface water, often where disturbed, readily penetrates sandy alluvial deposits, thus often first perennial to re-colonize flood-disturbed river banks; in open communities to low closed wooded communities, sometimes apparently associated with *P. australis* but this due to changes in habitat, particularly in regard to soil/water relations, since *P. mauritianus* occurs in lower water-table or better drained soils than *P. australis*; abundant, often dominant, rarely extending down to where affected by extreme high water equinoctial spring tide; leaves of flowering culms not drying and falling as in *P. australis* but remain green until well after fruiting; flowers and apparent fruiting heads (March to) April to June (to July); during spring following flowering season flowering culms die back only distally, remainder of culm and branches persistent; leaves and distal aerial shoots eaten by stock and game; flowers visited occasionally by small brown beetle; aerial parts used in hut building 305, 5555, 6552, 6580, 6584, 6590, 6591, 6765

Diplachne fusca (L.) Beauv. ex Stapf
Tufted, culms erect, geniculately ascending or sometimes decumbent, rooting below, up to 93 cm tall; in periodically moist, slightly saline areas, just above high water ordinary spring tide; common; flowers September to July 300

Pogonarthria squarrosa (Licht.) Pilg.
Tufted, apparently perennial, culms up to 32 cm tall; on open sandbank of Mbokodweni River; rare; flowers September (to February) 5836

Eragrostis aspera (Jacq.) Nees
Annual, tufted, culms 15-50 cm tall; in secondary grassland on sandy bank of Mbokodweni River; rare; flowers March to April 5556

E. capensis (Thunb.) Trin.
Perennial, tufted, culms up to 90 cm tall; in open grassland and open scrub, sandy soil; very common; flowers and fruit September to May 11, 761

E. chapelieri (Kunth) Nees
Perennial, tufted, culms up to 70 cm tall; in open grassland and open scrub on Isipingo Flats and Mbokodweni Valley, sandy soils; locally frequent; flowers and fruit August to June 5327

E. cilianensis (All.) Lutati
Annual, tufted, outer culms geniculately ascending, sometimes rooted from lower nodes, 30-50 cm high; ruderal; common; flowers December to March (to July) 748

E. ciliaris (L.) R. Br.
Annual or possibly short-lived perennial, tufted, culms up to 80 cm tall; in open grassland and open scrub, sandy soil; very common; flowers (July to) September to May (to June) 364

E. curvula (Schrad.) Nees
Perennial, tufted, culms up to c. 100 cm tall, but also represented on Isipingo Flats by robust form (Ward 1326) with culms up to 150 cm tall; in open grassland and disturbed areas throughout; very common; flowers (July to) August to April (to June) 884, 1326, 4666

E. pilosa (L.) Beauv.
Annual, tufted, culms up to 65 cm tall; ruderal; common; flowers December to April 4861, 4967

Melica racemosa Thunb.
Perennial, rhizome short, culms up to 85 cm tall; in open scrub on former flood-plain of Mlazi River, sandy soil; locally common; flowers September 5866

Poa annua L.
Small tufted annual, culms 3-15 cm tall; in disturbed open places, occasional, although common and aggressive in lawns and on Golf Course developing late May or June generally where shaded, killed by advancing summer in open places but survives for longer periods in somewhat moist partly shaded situations; flowers and fruits (May to) June to December (to January) (February); fruit eaten by birds (i.a. Yellow Weaver, Bronze Mannikin and House Sparrow) elsewhere 6290

Triticum aestivum L.
Annual, tufted, culms 65 cm tall; on refuse dump; very localized; flowers October 6635

Bambusa balcooa Roxb.
Robust perennial, rhizome short, forming large clumps, culms up to 15-16 m tall; in low-lying scrub and woodland; occasional; flowers periodic, very rare, observed March; culms used for various purposes 756

CYPERACEAE

Cyperus albostriatus Schrad.
Perennial, rhizome elongated, flowering stems up to c. 65 cm tall; in light shade in woodland or forest, at forest margin or in open places on mesoclines; very common; flowers October to June 143

C. articulatus L.
Perennial, rhizome elongated, stems up to 240 cm tall; in moist sand of river bank, or in shallow water, often slightly brackish, sometimes associated with *Phragmites australis*; common; flowers August to May (to July) 390, 5816

C. compressus L.
Annual, tufted, stems up to 50 cm tall; in disturbed moist places; frequent; flowers November to March 661, 4852

C. corymbosus Rottb.
Perennial, rhizome elongated and tuberous, stems up to 140 cm tall; in low-lying grassland; frequent; flowers September to March 664

C. denudatus L.f. var. *sphaerospermus* (Schrad.) Kük.
Perennial, tufted, rhizome compacted, flowering culms often weak, bending over; heads often proliferate; in moist places; very common; flowers September to April (to June) 470, 498, 522, 600

C. difformis L.
Annual, tufted, stems up to 50 cm tall; in moist places, often marginal to open water, generally where disturbed; common; flowers November to March 737, 5344

C. distans L.f.
Annual, possibly sometimes short-lived perennial, flowering stems up to 75 cm tall; on river banks and alluvial plain, where disturbed, sandy soils; frequent; flowers November to March 6162

C. esculentus L.
Apparently sometimes annual, generally perennial with tubers on slender rhizome, stems up to 65 cm tall; in moist places, particularly where disturbed, sandy soil; very common; flowers (July to) August to May; tubers edible 607, 609, 4851

C. fastigiatus Rottb.
Perennial, rhizome short, stems up to 120 cm tall; in moist places at margin of reed-swamp and along drains; formerly very common; flowers (August to) September to March 471, 1360

C. immensus C.B. Cl.
Robust perennial, tufted, sometimes loosely so, rhizome abbreviated, stout, sometimes very shallow, almost or in part exposed, flowering stems up to 160 cm tall; in upper reed-swamps, moist depressions and along river banks, very common; flowers September to March (to April) 501

C. latifolius Poir.
Robust perennial, rhizome elongated, flowering stems up to c. 120 cm tall; in freshwater swamps, particularly marginal to reed-swamp, and along river banks, generally extending into water; common; flowers October to April 577, 620

C. natalensis Hochst.
Perennial, rhizome elongated and tuberous; in sand and sandy soils, with wide range of soil water requirements; very common throughout in open areas; two forms with intermediates, predominate: (a) low (flowering culms may be only 10-15 cm above ground) leafy form, generally in relatively loose wind-blown sand, and (b) taller (flowering culm up to approximately 140 cm tall) in more stable situations in open grassland, often low-lying areas; flowers November to March 144, 664a, 758, 1281, 4882, 4884

C. obtusiflorus Vahl [=*C. compactus* Lam.]
Perennial, rhizome stout, compacted or short, flowering stems up to 90 cm tall; in grassland, low-lying area; common; flowers (July to) September to March (to May), elsewhere visited by beetles 147

C. prolifer Lam.
Perennial, rhizome short, stems up to 80 cm tall; heads proliferate readily; in freshwater swamps; frequent; flowers September to May 469

C. rotundus L.
Perennial, rhizome elongated, slender with tubers, stems up to 50 cm tall; in somewhat moist places, particularly where disturbed; common; flowers November to March 590, 749, 1212, 5350

C. sexangularis Nees
Perennial, rhizome stout, abbreviated, forming clumps, stems up to 120 cm tall; with grasses in low-lying area, sandy soil; frequent; flowers August to December; eaten by various herbivores 456

C. tenax Boeck.
Perennial, rhizome abbreviated, ± vertical, stems up to c. 40 cm tall; in open scrub, coarse sandy alluvium; locally frequent; flowers December to January 6838, 6839

C. textilis Thunb.
Perennial, in clumps, rhizome stout, abbreviated, stems up to 90 cm tall; in open vegetation in moist situations, sandy soil; frequent; flowers September to December; eaten by various herbivores 462

C. tuberosus Rottb. [= *C. rotundus* L. var. *tuberosus* Rottb.]
Perennial, apparently short lived, rhizome elongated, stems up to 50 cm tall; in disturbed places, in sand with humus, such as disturbed woodland; locally common; flowers December to April (to June) 742, 6240

C. zollingeri Steud. ex descr.
Annual, tufted, stems 40-60 cm tall, heads proliferate; in recently partially cleared woodland, reddish sandy soil; locally frequent; flowers March 6165

Pycreus ferrugineus C.B. Cl.
Apparently annual, tufted, stems up to 36 cm tall; in moist, generally disturbed, places; common; flowers November to March 735

P. flavescens (L.) Beauv. ex Reichb.
Apparently annual only, tufted, flowering stems 10-40 cm tall; in moist open places, in sand or clayey sand; frequent; flowers August to April 5818, 6711

P. mundtii Nees
Perennial, rhizome elongated, flowering stems weak, trailing; early colonizer of moist sand on flood-disturbed stream banks and early in general hydrosere, extending over water ahead of emergent aquatics where water moving (even if only slightly); very common; flowers March to December 523, 1229

P. polystachyos Beauv.
Perennial, apparently sometimes annual, tufted, rhizome abbreviated, stems up to 100 cm tall; in open, often disturbed, moist places, fresh or slightly saline (bases sometimes covered at very high tides); common; flowers (August to) October to April (to July) 142, 267

Juncellus laevigatus C.B. Cl.
Perennial, rhizome generally elongated, bearing tufted aerial stems 12-45 cm tall; in moist places, fresh or somewhat saline; very common; occasional, during rainy season and following floods, as early colonizer of silt-covered intertidal banks in lagoon, generally killed off later if salinity of inundating water increases; also pioneer in shallow soil in concrete-lined drainage canal (Isipingo North); flowers all months 141, 265, 1271, 5637

Mariscus congestus C.B. Cl.
Annual, forming small tufts, stem up to 60 cm tall; in moist places on river banks; frequent; flowers November.. 1230

M. dubius (Rottb.) Hutch. [=*M. dregeanus* Kunth]
Perennial, tufted, flowering stems 10-40 cm tall; in open grassland or in light shade marginal to forest or woodland; common; flowers October to April (to July); eaten by game elsewhere 544, 6166

M. macrocarpus (Boeck.) Kunth [=*M. macer* Kunth]
Tufted, apparently perennial, flowering stems up to 100 cm tall; heads sometimes proliferate; in disturbed dune forest and in open parts, including dwarf salt-spray zone on steep seaward-facing hills; common; flowers September to March 731, 747, 4887, 6167

M. riparius Schrad.
Perennial, rhizome stout, very short, flowering stems 40-120 cm tall; in moist open areas and riparian grassland; common, in parts dominant; flowers September to December..... .... 525, 564, 565, 591, 621

M. sieberanus Nees
Short-lived perennial, possibly annual, tufted, stems up to 40 cm tall; in disturbed places, open or partly shaded, sandy or loam soils, common; flowers October to April (to June).. 566

M. vestitus (Hochst. ex Krauss) C.B. Cl.
Perennial, tufted, flowering stems up to 30 cm tall; pattern and colour of inflorescence variable; in grassland, open areas, sandy soil; very common; flowers September to March 541, 542, 543, 546, 547, 583, 615, 743, 757, 759

Kyllinga alata Nees [= *K. alba* Nees var. *alata* (Nees) C.B.Cl.]
Perennial, rhizome stout, short; stem up to 35 cm tall; in low-lying part of open grassland, sandy soil; common; one of first to flower after grass fires, flowers August to November (or May on April burn) 554

K. elatior Kunth
Perennial, rhizome generally elongated, flowering stems 11-60 cm tall; in moist places, often with secondary hygrophilous grasses; common; flowers September to May (to June) 310, 4961, 4965, 4968

K. erecta Schum.
Perennial, rhizome elongated, often much branched, flowering stems slender, up to 45 cm tall; in generally open, sometimes lightly shaded, places, often somewhat moist sandy soils; frequent; flowers October to March 5309, 6729

K. nemoralis (Forst.) Dandy
Perennial, stoloniferous and shallowly rhizomatous, well branched elongated horizontal system, flowering stems up to 75 cm tall; heads sometimes proliferate; in moist, partly shaded area; locally abundant; flowers November to May (to June) 1250

K. odorata Vahl [=*K. cylindrica* Nees]
Perennial, tufted, rhizome compacted or shortly elongated; stems slender, up to 75 cm high; in low-lying grassland, loamy sand; frequent; flowers November to March .. 6728, 6810

Fuirena hirsuta (Berg.) Forbes [=*F. glabra* Kunth]
Perennial, rhizome short, flowering stems up to 120 cm tall; in moist places near river; common; flowers August to April 753, 839

F. sp. (genus under revision)
Perennial, rhizome short, flowering stems up to 75 cm tall; in moist sand of river bed; occasional; flowers January . 1320

Scirpus cernuus Vahl
Tufted, possibly perennial, flowering stems up to 20 cm tall; in moist sand of river bed, early colonizer; frequent; flowers January 1316

S. chlorostachyus Levyns
Annual, forming small tufts, flowering stems 1-12 cm tall; in moist sand and/or mud on river banks; frequent; flowers August to November 1227, 5855

S. littoralis Schrad.
Perennial, rhizome well developed, internodes short; flowering stems up to 280 cm tall; in tidal river and estuary where salinity lowered through freshwater influx, although recorded in tidal water of up to 31‰ salinity; very common, often forming extensive pure stands; flowers (August to) October to June (to July) 266, 1151

S. paludicola Kunth
Perennial, tufted, flowering stems up to 45 cm tall; in moist sand or in shallow water; locally frequent; flowers October to March 736

S. prolifer Rottb.
Annual or possibly short-lived perennial, tufted, rhizome compacted, occasionally elongated; flowering heads often proliferate, stems slender bending over eventually; in moist places and in shallow freshwater; common, often in recently disturbed situations; flowers August to March; small black bee apparently collecting pollen (on one occasion) 1214

Eleocharis limosa Schultz
Perennial, aerial stems up to approximately 100 cm tall, tufted on elongated rhizome; heads often proliferate; in moist places, river banks and swamps; common; flowers August to March (to June); flower parts eaten by juvenile long-horned grasshopper and small beetle 461, 5817

Fimbristylis complanata (Retz.) Link.
Perennial, rhizome compacted or short; flowering stems up to 90 cm tall; in moist places, open area near small vlei; occasional; flowers (August to) September to April .. 734

F. dichotoma (L.) Vahl
Annual or short-lived perennial, tufted or rarely rhizome elongated, flowering stems up to 100 cm tall; in low-lying riparian grassland, sandy soil; common; flowers November to April 751

F. ferruginea (L.) Vahl
Perennial, apparently short-lived, or annual, tufted, flowering stems 35-100 cm tall; in moist low-lying places, fresh or slightly saline; very common, important associate of *Stenotaphrum secundatum* in ecotone between true-halophytes and mesic grasses; occasionally acts as a ruderal in sandy soils; flowers October to May (to June) 140, 301, 617, 662, 1002, 6239

F. hispidula (Vahl) Kunth [=*F. exilis* (Kunth) Roem. & Schult.]
Annual, tufted, flowering stems 2-40 cm tall; in slightly moist disturbed places, in sand; common; flowers July to April 610, 755, 5819

F. obtusifolia (Lam.) Kunth
Perennial, tufted, flowering stems up to 50 cm tall; in slightly saline soil, in low-lying area adjacent to estuary just above high water ordinary spring tide, often associated with *F. ferruginea* and facultative halophytic grasses; common; flowers November to May 311, 663

Bulbostylis contexta (Nees) Bodard
Perennial, tufted, flowering stems up to 70 cm tall; in open grassland, especially in semi-bare patches, in sandy soil; very common; flowers September to March (to April) 985, 1012, 1217, 1282, 6160

B. humilis (Kunth) C.B. Cl.
Annual, tufted, flowering stems up to 20 cm tall; in disturbed places, sandy soils, often somewhat moist; locally frequent; flowers December to March (to April) ... 5317

Abildgaardia ovata (Burm. f.) Kral. [=*Fimbristylis ovata* (Burm. f.) Kern]
Perennial, tufted, rhizome compacted or short, flowering stems up to 40 cm tall; in open grassland, sandy soil; common; flowers September to March 556

Carex cognata Kük.
Perennial, rhizome short, flowering stems up to 100 cm tall; in moist places, sometimes lightly shaded; frequent; flowers November to February 1221

ARECACEAE (PALMAE)

Phoenix reclinata Jacq.
Tree, up to 11 m tall where protected and where water table high, stem 15-20 cm d.b.h., young shade leaves up to 430 cm long; member of late hydrosere and early mesosere in open areas and in riparian woodland; very common, often dominant in moist places; occasionally pseudo-epiphytic, in forks of large trees; rare in maritime woodland; flowers November to December (to January); fruit matures (March to) April to June (to July); flowers visited by honey bee (for pollen) and several small insects, female flowers with some exudate visited by flies and ants; fruit eaten by birds and various mammals, including man 857, 1251

ARACEAE

Zantedeschia aethiopica (L.) Spreng.
Herb with tuberous rhizome, leaves radical; in wet places; locally frequent; flowers (May to) July to January; visited by honey bee and small brown ant 599

Colocasia antiquorum Schott
Herb, rhizome stout, tuberous; petiole stout, up to 180 cm tall; in clayey loam on stream bank or in shallow running water of Sipingo River above tidal influence; locally frequent; flowers April; rhizome, pedicel and lamina edible when cooked 5551

Stylochiton natalense (Sond.) Schott
Acaulescent herb, rhizome tuberous, leaves radical approximately 20 cm total length; in light shade in riparian short woodland, in loamy sand; locally occasional; flowers not observed locally, elsewhere September to October 5307

Pistia stratiotes L.
Stoloniferous herb, stem much reduced, leaves sessile in rosettes, up to 10 cm long, often much shorter, in recently established (early 1969) population in Sipingo River whole plants very robust with leaves up to 29 cm long; floating in open water in drains from reed-swamp and in Sipingo River above tidal influence, locally common; flowers December to June 1294, 6735, 6738

LEMNACEAE

Spirodela punctata (G. Meyer) Thompson
Small herb, floating in impounded rainwater; locally abundant; flowers not seen 7609

Lemna gibba L.
Small herb, floating in drainage canal in swamp; locally abundant; flowers not seen 5864, 7675

Lemna sp. cf. *L. gibba* L. or *L. minor* L.
Small herb, floating in freshwater pools, drains and slowly-flowing stream; often abundant, completely covering surface of open water; flowers not seen; aphids, in quantities, feed at times on massed thalli 1220, 5860, 5862

L. perpusilla Torrey
Small herb, floating in impounded rainwater; locally abundant; flowers May, June, November 7608

Wolffia arrhiza (L.) Horkel ex Wimmer
Minute rootless herb, floating in freshwater pools and drains; common, sometimes abundant locally; flowers not seen 1295, 5865

FLAGELLARIACEAE

Flagellaria guineensis Schum.
Robust herbaceous climber in woodland and forest throughout; very common; flowers October to December (to January); fruit mature late January to April, eaten, elsewhere, by birds (teste I.F. Garland): stems used for tying thatch and in basket weaving 537

COMMELINACEAE

Commelina africana L. var. *krebsiana* (Kunth.) C.B. Cl.
Perennial herb, stems erect or decumbent 12-25 cm tall, in open grassland, short or often where formerly disturbed; sandy soils; common; flowers September to April, visited by honey bee (for pollen) and pollen-eating fly (Syrphidae) 1201, 6221

C. benghalensis L.
Included under this are apparently two 'forms', both herbs with reddish- to purple-brown stiff hairs on leaf sheath, stems weak, leaning, decumbent or ascending, up to c. 50 cm high: (i) annual, in disturbed open to lightly shaded places, generally with cleistogamous flowers from shaded or subterranean parts as well as ordinary, usually pale blue flowers, (ii) possibly perennial, although subterranean parts not well developed, petals larger than (i) and deep blue, no cleistogamous flowers seen, occurs with grasses at margin to woodland and forest often where partially disturbed; flowers August to May (to June); plants eaten, apparently by Bushbuck 344, 4544, 6222, 6225

C. diffusa Burm. f.
Stoloniferous, decumbent or semi-scandent herb, up to 65 cm high, in low-lying moist places including river banks, generally with extensive horizontal development in disturbed, open places, and stems up to 5 m or more long, rooting below, may become disconnected from original base; common; flowers (July to) October to May (to June) 6224

C. erecta L. [=*C. gerrardii* C.B. Cl.]
Perennial weak-stemmed herb procumbent to semi-scandent, in open places and short grassland and in dwarf salt-spray zone on and above supralittoral rocks, often first to colonize disturbed places; sandy soils; common; flowers August to May 6247

Aneilema aequinoctiale (Beauv.) Kunth
Decumbent herb, often somewhat scandent, in moist places often marginal to low-lying woodland-forest; common; flowers November to June (to July) 326, 6226

Coleotrype natalensis C.B. Cl.
Perennial herb, flowering stems erect up to c. 50 cm tall from creeping shallow rhizome; in short forest on steep inland sides of main hills and mesocline of Jeffels' Hill, reddish sandy soils, and in riparian woodland on alluvial sand in Mbokodweni Valley; common; not recorded from dune forest (white sand); flowers October to April 3756, 4849, 6202

PONTEDERIACEAE

Eichhornia crassipes (Mart.) Solms
Herb, main stem much reduced, stolons axillary, leaves with swollen petioles, size and form very variable, apparently influenced by degree of exposure to wind and sun, few cm to 60 cm or even more, long; floating, in all open freshwater; abundant; occasionally rooted in permanently wet soil, if so rhizome compacted fairly stout and up to 30 cm long; flowers November to May 286

JUNCACEAE

Juncus dregeanus Kunth
Annual or perennial, tufted, flowering stem up to 70 cm tall; in moist places, particularly sandy river banks; common; flowers and fruit August to March 528, 1228, 1231, 1318, 5352

J. kraussii Hochst. (Included by Weimarck (1946) in *J. maritimus* Lam.)
Perennial, rhizome short or somewhat elongated, upright stems and leaves in clumps up to 100 cm tall; on mud flats, at approximately high water level ordinary spring tides, or slightly higher, bases covered at exceptionally high tides; abundant and forming pure stands over considerable area between upper mangroves and mesic grassland (where freshwater influence more noticeable, stands not as extensive and plants taller); flowers (October to) November to January (to February); upright stems and leaves used for sleeping mats 302, 648

J. sp. (very similar to *J. kraussii* Hochst. but capsule different)
Habit as above but up to 170 cm tall; in grassland on flood-plains of Mlazi River as it joins lagoon; common; flowers October 616

J. sp. (perhaps *J. kraussii* Hochst. *sensu lato*)
Habit as above but approximately 150 cm tall, in small clumps in riparian grassland; occasional; flowers October ... 618

J. lomatophyllus Spreng.
Perennial, rhizome horizontal and/or somewhat vertical, flowering stems up to 75 cm tall; in moist soil on river banks; frequent; flowers September to November ... 1225

J. oxycarpus E. Mey. ex Kunth subsp. *australis* Weim.
Tufted, up to 75 cm tall; in moist soil on river bank; occasional; flowers September (to March) 5831

LILIACEAE

All perennial and herbaceous unless otherwise stated.

Gloriosa superba L.
Rootstock tuberous, stem scandent or shortly erect; throughout area except in deep shade; usually in well-drained soils; very common; flowers December to March (to June); tuberous rootstock taken to determine sex of child to be born 105

Androcymbium decipiens N.E. Br. [=*A. longipes* Bak.]
Perennial, acaulescent, corm small; in open scrub and grassland, low-lying sandy soils; locally common; flowers immediately after winter and early spring grass-fires before leaves fully developed. July to August 5809

Bulbine asphodeloides (L.) Roem. & Schult. (slender Natal form)
Rhizome compacted, aerial parts in clumps, up to c. 50 cm tall; in open grassland, sandy soil; common; flowers August to November (to March) 3765

Anthericum saundersiae Bak.
Rhizome abbreviated, small, flowering stem 10-30 cm tall; in open grassland or lightly shaded marginal to woodland and forest, sandy soil; common; flowers July to March 587, 958

Trachyandra asperata Kunth (a rather eglandular form)
Tufted, rhizome compacted, up to 50 cm tall; in secondary grassland and open scrub on Isipingo Flats, sandy soil; occasional; flowers September to February 5330, 5900

Chlorophytum comosum (Thunb.) Jacques (but leaves larger than description)
Rhizome very short, peduncle slender, weak, distal part of inflorescence leafy and proliferates freely; in ground layer in short woodland-forest just above tidal river; locally common; flowers October to February 1007

C. modestum Bak.
Rhizome very small, compacted, roots tuberous, peduncle erect, 10 to 20 cm tall; in shade in woodland or at forest margin, also within dune forest where disturbed; common; flowers October to May 314, 575, 4905

Eriospermum natalense Bak.
Rootstock tuberous, amongst grasses in open scrub near river; locally common; flowers, before leaves, August to September (to October) 973

Aloe saponaria (Ait.) Haw.
Subshrub, acaulescent or stem short; in scrub in low-lying areas; frequent; flowers (April to) May to August, elsewhere visited by Olive Sunbird 1152

Aloe thraskii Bak.
Stem unbranched, up to 300 cm tall, up to c. 8 cm d.b.h.; on steep seaward-facing hills, marginal to disturbed places or in dwarf salt-spray zone where dominant, also common in short dune scrub; flowers June to July, fruits mature mid-August to October; flowers visited by bees, in particular honey bee for pollen or nectar, flies (Muscidae, Drosophilidae, Tachinidae and others), butterflies as well as probing birds i.a. Indian Myna, Cape Weaver and Black-eyed Bulbul 1153

Tulbaghia violacea Harv.
Rootstock tuberous, tunicated above; in grassland near old dwelling site, apparently garden escape; locally frequent; flowers October 624

Dipcadi viride (L.) Moench.
Bulbous; in open grassland, sandy soil; common; flowers October to March 595, 4872

Ornithogalum virens Lindl.
Bulbous; in open grassland or disturbed places, sandy soil, generally low-lying fairly moist areas; common; flowers August (following recent fire) to January, elsewhere visited by wasp 598

Drimiopsis maculata Lindl.
Bulbous; in open short grassland or in light shade marginal to or within woodland or forest; common; flowers September to November (to April, where disturbed) . 458

D. maxima Bak. [=*Resnova maxima* (Bak.) v.d. Merwe]
Bulbous; in light shade in woodland just above tidal river and in open maritime woodland-scrub; common; flowers October to November 562, 1203

Ledebouria cooperi (Hook. f.) Jessop [=*Scilla saturata* Bak.]
Bulbous; in open grassland, sandy soil; common; flowers August to October; periodic defoliation by unidentified lepidopteran larvae, early spring; bulbs used medicinally 614, 972

Ledebouria sp.
Bulbous; in open grassland, sandy soil, low-lying area; common; flowers September 460

Dracaena hookerana K. Koch
Shrub, stems unbranched or sparingly so, often branched after damage or few may arise from collapsed original stem, mostly up to 180 cm tall occasionally up to 270 cm tall, 5 to 7 cm diameter; in woodland and forest; common; flowers November to January; apparently bird-distributed 4815

Sansevieria hyacinthoides (L.) Druce [=*S. guineensis* (L.) Willd, *S. thyrsiflora* Thunb.]
Acaulescent, rhizome creeping; in woodland and forest throughout; common; flowers January 651

Asparagus africanus Lam.
Suffrutex, stems semi-scandent or weakly erect; in open scrub or in light shade of forest, generally marginal; frequent; flowers September to November, elsewhere visited by wasp and beetle, and plants eaten by game 3749

A. densiflorus (Kunth) Jessop [=*A. sprengeri* Regel]
Slender suffrutex, roots with tubers, stems partly erect, more generally shortly trailing, sometimes somewhat scandent; in dune scrub, early maritime and estuarine woodland and in dwarf salt-spray zone on and above supralittoral rocks; very common, important member of early supralittoral lithosere; flowers December to April; roots and rhizome used medicinally 253, 4921

A. falcatus L. var. *falcatus*
Stems robust, lianous; in woodland and forest; common; flowers October to February, elsewhere visited by honey bee and wasp; fruit eaten by birds 823

A. setaceus (Kunth) Jessop [=*A. plumosus* Bak.]
Stems slender, scandent; in woodland and forest, particularly marginal; very common; flowers April 345

A. virgatus Bak.
Stem erect, up to c. 80 cm tall; in open, low-lying scrub or marginal to riparian woodland or on mesocline of Jeffels' Hill; frequent; flowers September to October; elsewhere plants eaten by game 561

Behnia reticulata (Thunb.) Didr.
Stem tough, somewhat woody, scandent; in woodland and forest; common; flowers September 871

Smilax kraussiana Meisn.
Stems tough, somewhat woody, scandent or trailing; in scrub, woodland and forest, invader of open grassland, where readily regenerates from base after fires, sandy soils; very common; flowers January to September; apparently bird-distributed 357, 763, 899, 5301

AMARYLLIDACEAE

Perennial herbs

Haemanthus albomaculatus Bak.
Bulb small, acaulescent, leaves always present; in low-lying woodland-forest and dune forest and in dwarf salt-spray zone at base of seaward-facing main hills; very common, abundant in parts; flowers end-May to August 914

H. magnificus Herb.
Bulb large, stem annual, stout, soft, short, bearing leaves only; in open grassland or, more particularly, marginal to or just within woodland and forest; common; leaves and stem produced August to September, die back completely April to June; flowers late July to early September, elsewhere visited by large black ant and Olive Sunbird 454, 457

H. puniceus L.
Bulb small, acaulescent, leaves always present; in dune forest (all stages), in woodland-forest and in dwarf salt-spray zone; common; flowers December to January (to April) . 1354

Zephyranthes candida Herb.
Bulbous, aerial parts annual; alien, an escape generally limited to disturbed short-grassland near dwellings; frequent; flowers November to January 1357

Crinum macowanii Bak.
Bulbous; in sandy soil in open scrub and open woodland; occasional; flowers September to November 5897

Cyrtanthus mackenii Hook. f.
Bulbous; in open secondary grassland on Isipingo Flats, apparently garden escape; locally occasional; flowers July to September 5890

HYPOXIDACEAE

Hypoxis angustifolia Lam. var. *angustifolia*
Corm cylindric, small; in fairly moist places in low-lying grassland; frequent; flowers October to November .. 971

H. rooperi S. Moore
Corm variable in size up to approximately 15 cm long x 8 cm diameter, obconical; in open grassland, sandy soils; common all over; flowers, depending upon grassfires or lack of other vegetation in all months, particularly August to October (to February); visited by honey bee and, elsewhere, by other bees, ants and flies 398, 459

DIOSCOREACEAE

Dioscorea cotonifolia Kunth
Herbaceous climber, rhizome compacted, roots tough, fibrous well developed, often distally tuberous; aerial stem well developed, extending to upper canopy, apparently perennial, rather tough; in woodland and at forest margins; very common, especially in low-lying woodland-forest; flowers November to January; leaves eaten by Bushbuck elsewhere 652, 1146, 1147

D. crinita Hook f.
Herbaceous climber, aerial stem apparently annual; in woodland, maritime scrub and at forest margins; common; flowers January to March 654, 732

D. diversifolia A. Rich. [=*D. multiloba* Kunth]
Low climber, stem herbaceous apparently annual; rootstock tuberous; in open woodland and scrub; occasional; male flowers April to May, elsewhere flowers January to March 4976, 6992

D. sylvatica (Kunth) Ecklon var. *paniculata* Burkill
Herbaceous climber, stem tough annual; rootstock large tuberous, with hard outer protective layer; in maritime scrub, dune forest and woodland-forest; frequent; flowers March to April 376, 865, 4924

IRIDACEAE

Perennial herbs

Dietes vegeta (L.) N.E. Br.
Rhizome stout, short; peduncle often elongated and reproduces vegetatively distally; in woodland and forest throughout; very common; flowers (September to) November to May 297

Sisyrinchium micranthum Cav.
Rhizome small, compacted, flowering stem erect or, where trampled, almost prostrate at first, in disturbed low-lying place, silty sand, Isipingo Flats; very locally frequent; flowers September to November 6798

Aristea ecklonii Bak.
Rhizome abbreviated; peduncle up to 100 cm tall; in low-lying grassland and open scrub; common; flowers October to December (to March) 527

Crocosmia aurea Planch.
Corm with fibrous tunics; 50-100 cm high; in light shade on stream banks, in woodland and in dune forest; frequent; flowers February to April (to July) 770, 4880

Gladiolus gueinzii Kunze [=*G. sabulosus* Lewis]
Corm with fibrous tunics; 25-40 cm high; in sand in dwarf salt-spray zone on or just above supralittoral rocks, and in open fixed dune communities; frequent; also in disturbed sandy soil near reed-swamp, rare; flowers October to January 1375, 3022

G. natalensis (Eckl.) Reinw. ex Hook. [=*G. tysonii* Bak.]
Corm with fibrous tunics; 50-160 cm high; in low-lying open grassland; frequent; flowers October to November, April to May 594, 3771

Anomatheca laxa (Thunb.) Goldblatt [=*Lapeirousia laxa* (Thunb.) N.E. Br.]
Corm small, tunics fibrous; 15-30 cm high; in light shade, all over, sandy soils; very common; occasional in disturbed sandy soils near reed-swamp; flowers (June to) August to October (to November) 499

STRELITZIACEAE

Strelitzia nicolai Regel & Koern.
In clumps, often large; rhizome abbreviated; stems stout, peripherally woody, up to 950 cm tall, (considerably shorter on sea-facing slopes), up to 12 cm d.b.h.; all over, except in mature dune forest and forest on xerocline of main hills; very common especially where water table high, or on hill slopes subjected to on-shore breezes (these also mesoclinal); flowers mostly March to September but few in any month, visited elsewhere by honey bee, wasp, ants, flies and sunbirds; seeds apparently bird (or bat) distributed; leaves used as temporary shelters, elsewhere, dried pedicel and midrib stripped for weaving prepuce covers and baskets 854

CANNACEAE

Canna indica L.
Perennial herb, rhizome stout; aerial parts 50-150 cm tall; in moist places on Isipingo Flats, above tidal influence; common; flowers November to July, visited elsewhere by sunbird 5003, 5549

ORCHIDACEAE

Bonatea speciosa (L.f.) Willd.
Terrestrial, roots tuberous, stem erect up to 90 cm tall, leaves cauline; in scrub and woodland in low-lying areas and in dwarf salt-spray zone, sandy soils; common; flowers July to September 913

Disa polygonoides Lindl.
Terrestrial, roots tuberous, stem erect up to c. 50 cm tall; in low-lying hygrophilous grassland, sandy silt; locally occasional; flowers September to October 6789

Polystachya sandersonii Harv.
Epiphyte, sympodial, erect stems up to 15 cm tall, bases form pseudo-bulbs, rather compacted; in dune forest and forest on inland-facing slope of main Isipingo Beach Hill; common; flowers October to December (to January) 996

Eulophia speciosa (R. Br. ex Lindl.) Bol. [=*Lissochilus speciosus* R. Br.]
Terrestrial, rhizome swollen irregularly, sympodial, leaves basal; flowering stem up to 75 cm tall; in open grassland and scrub, sandy or loam soils, particularly low-lying areas; common, also occasional in open fixed dune communities; flowers September to December (to June); large black ant frequently visits buds and young flowers for exudate at base of bracts and outer perianth parts 596, 623

Tridactyle bicaudata (Lindl.) Schltr.
Epiphyte, stem monopodial, elongated; in dune forest; localized; flowers December to February .... (Ward s.n. in Natal Herb. No. 41291)

Microcoelia exilis Lindl.
Epiphyte, stem monopodial much abbreviated, leafless; in short woodland-forest on xerocline of main hill; locally common; flowers November 1242

Cyrtorchis arcuata (Lindl.) Schltr.
Epiphyte, stem monopodial, elongated; in forest and woodland-forest; common, occasional on *Bruguiera gymnorrhiza* Lam. in mature mangrove communities;

flowers January to February (to March), visited elsewhere by small black ant 4826

Mystacidium flanaganii (Bol.) Bol.
Epiphyte, stem monopodial, abbreviated; on small trees in short woodland-forest on steep west-facing slope of main Isipingo Beach Hill; locally frequent; flowers (May to) June 5677

M. venosum Harv. ex Rolfe
Epiphyte, stem monopodial, abbreviated; in dune forest, particularly on large *Podocarpus latifolius* R. Br.; common; flowers May 352

CASUARINACEAE

Casuarina equisetifolia Forst.
Evergreen tree, up to 25 m tall, planted originally by man but spread in low-lying parts where soil sandy, sparsely covered and where protected from grass fires; frequent; flowers October to April 1331

SALICACEAE

Salix babylonica L.
Small tree, 3 m tall, on stream bank; rare; flowers November 1248

ULMACEAE

Celtis africana Burm. f.
Decidious tree up to 15,25 m tall, stem up to 71 cm d.b.h. (tree 12,4 m tall); in woodland and forest where not subjected to strong on-shore winds, generally early in forest succession under shade-producing precursors or where forest disturbed; very common; readily hedged by on-shore winds; leaves dropped from April or May, new leaves July, August or September; flowers usually with early new leaf, July to October; fruit mature (January to) March to April (to August); severe summer drought may cause partial leaf drop, with new leaves and flowers following rains in March; common host of *Loranthus quinquenervis*, often heavily infested; Cercopidae larvae (spitbugs) often on distal branches; leaves and twigs eaten by Bushbuck and Blue Duiker; leaves sometimes eaten by beetle larvae; flowers apparently mainly wind-pollinated but also visited by flies; fruit eaten by several birds; bark sometimes removed as though for medicine 488

Trema orientalis (L.) Blume
Evergreen, quickly growing tree, up to 9,4 m tall (stem 38 cm d.b.h.); forest precursor; common, particularly at disturbed forest margins; not tolerant of fire or deep shade; flowers August to June; fruit mature November to August; leaves and twigs eaten by Bushbuck and domestic stock; elsewhere flowers visited by honey bee; fruit eaten by birds; bark frequently removed as though for medicine, and sometimes in long strips as though for fibre 511

Chaetachme aristata E. Mey ex Planch.
Evergreen tree, up to 13,5 m tall (stem 76 cm d.b.h.); in woodland and forest; very common throughout except where directly exposed to salt-spray-bearing winds; generally stems several or many small produced from lower main stems, but in deep shade in dune forest stem single, no coppice; flowers July to March; fruit mature April to October (to December); frequently parasitized by *Loranthus quinquenervis*; young plants browsed by game; fruit eaten by birds, i.a. Purple-crested Lourie, elsewhere, (teste T.B. Oatley) 774, 1020

MORACEAE

Morus sp. cf. *M. alba* L.
Deciduous tree up to 6,5 m tall; in disturbed generally somewhat moist places, especially on river banks above tidal influence; frequent; flowers (April), August to September; fruit mature September to October; male flowers visited by pollen-gathering honey bee; fruit eaten by birds and man 5550, 5833, 5851, 5852

Ficus burkei (Miq.) Miq. [=*F. petersii* Warb.]
Tree up to 9,5 m tall, generally hemi-epiphytic at first, later 'strangles' support; in low-lying woodland and in dune forest; frequent; mature figs February to September, eaten by various birds 1246, 5304

Ficus burtt-davyi Hutch.
Shrub, rambling or scandent, often epiphytic in forest at first but seldom completely 'strangles' support, sometimes as chasmophyte in supralittoral rocks; very common throughout except where excessively moist and not fire tolerant; more or less leafless when in full fruit, figs mature at various times; parasitized by *Loranthus dregei*; insect-produced galls on stem frequent; figs eaten by several birds, including Black-collared Barbet 353, 375, 1021

F. capensis Thunb.
Tree, up to approximately 9 m tall; in low-lying and riparian woodland; common; adversely affected by even light on-shore winds; plank buttresses well developed in moist shaded situations; briefly deciduous, new leaves June to September; mature figs at various times; several insects feed on figs or superficial exudation thereof and figs eaten by various birds and mammals; bark removed for medicinal purposes 838

F. craterostoma Warb. ex Mildbr. & Burret
Tree, 6 m tall, crown spreading, in relict fringe vegetation on bank of Sipingo River; rare; figs mature May to June 5639

F. natalensis Hochst.
Tree, up to c. 8 m tall in woodland and forest; occasional; generally hemi-epiphytic at first, later 'strangles' support; figs mature at various times throughout the year, eaten by various birds and mammals 1016, 1370, 6209

F. polita Vahl
Represented by only one young specimen (4,5 m tall), within mapped area, in dune forest, no figs observed 367

F. vogelii (Miq.) Miq. [=*F. quibeba* Welw. ex Fical.]
Tree up to 14 m tall, mostly epiphytic at first; in tree-dominated communities throughout, except where directly exposed to salt-spray-bearing winds; common, important member of dune forest; briefly deciduous, new leaves August to September and often leafless when in full, mature fig; mature figs April to November, eaten by various birds 343

CANNABACEAE

Cannabis sativa L.
Robust herb up to c. 100 cm tall; in disturbed places, loamy sand; rare; flowers December to April. Cultivation and traffic in this drug punishable by law 6218, 6322

URTICACEAE

Urera cameroonensis Wedd. [=*U. woodii* N.E. Br.]
Scandent shrub, up to 2,5 m high, in short forest on inland-facing side of main Isipingo Beach hill and in dune forest, where canopy somewhat open; occasional; flowers not seen locally, elsewhere January 5120

U. tenax N.E. Br.
Deciduous tree up to 6 m tall (stem 24 cm d.b.h.) on xerocline of main Isipingo Beach hill; locally frequent; new leaves at or just after beginning of flowering period; flowers August to October 1240, 5880

Laportea grossa (Wedd.) Chew
Erect herb, up to c. 100 cm tall, in forest and closed woodland; very common; flowers February to May 339, 4855

L. peduncularis (Wedd.) Chew [=*Fleurya mitis* (E. Mey.) Wedd.]
Herb, erect or scrambling, up to c. 150 cm high, in wet places and in light shade throughout, where not too dry; very common, abundant in parts; flowers (July to) September to May (to June); pollen liberated explosively; leaves and distal stems eaten by Bushbuck 346, 846, 4856

Droguetia urticaefolia Wedd.
Perennial bushy herb up to c. 60 cm tall, often diffuse, in dune forest, especially where disturbed, in low-lying woodland-forest and in salt-spray zone immediately above supralittoral rocks; common; flowers October to June (to July) 348, 792, 4901

Australina acuminata Wedd.
Annual herb, stems slender erect or diffuse up to c. 45 cm tall; in open places, generally somewhat moist and in light shade in forest and woodland, often where disturbed; common; flowers September to March 3748, 4902

LORANTHACEAE

Hemi-parasitic epiphytic shrublets

Loranthus dregei Eckl. & Zeyh.
On wide range of woody plants - lianes, shrubs and trees - throughout; very common, particularly on *Hibiscus tiliaceus* L. and *Melia azedarach* L.; flowers at various times throughout year; pollen liberated explosively when, at anthesis, corolla lobes jerk open and curl backwards releasing spring-like anthers which generally break off from filaments, such action often triggered by sunbirds; visited, elsewhere, by butterfly (Pieridae) and sunbirds; fruit eaten by birds; bird-lime obtained from ripe fruit 23, 4667

L. kraussianus Meisn. var. *kraussianus*
On shrubs in open parts in dune forest, i.a. on *Grewia occidentalis* L. and *Deinbollia oblongifolia* Radlk.; common; flowers (August to) November to February . 463

L. quinquenervis Hochst.
In dune forest and woodland; common; locally recorded hosts - *Maytenus procumbens* (L.f.) Loess., *Chaetachme aristata* E. Mey. ex Planch. and *Celtis africana* Burm. f.; flowers December to June 317

Viscum nervosum Hochst. ex A. Rich.
In dune forest; occasional; hosts include *Uvaria caffra* E. Mey.; flowers December 1298

SANTALACEAE

Thesium asterias A.W. Hill
Herb, stem erect, up to c. 70 cm tall; semi-parasitic on roots of various grasses (i.a. *Imperata cylindrica* (L.) Beauv.) and forbs (i.a. *Acalypha petiolaris* Hochst. and *Centella coriacea* Nannfd.) in open grassland, sandy soils; very common, especially in low-lying parts; flowers October to March 993, 5284

POLYGONACEAE

Emex australis Steinh.
Annual herb, decumbent to procumbent; ruderal; very common; flowers at all times throughout the year; spinescent perianth aids external dispersal by animals 21

Rumex nepalensis Spreng.
Perennial herb, erect, up to 120 cm tall; in moist places; common; flowers March to November 382, 4661

R. sagittatus Thunb.
Low climber in scrub, woodland and at forest margins throughout; common; flowers February to March; fruit until June; flowers visited by honey bee (for pollen) . 386

Polygonum glutinosum Meisn. var. *capense* Meisn.
Erect herb up to 200 cm tall; in moist sandy soils on Isipingo Flats, often where disturbed; common; flowers (July to) September to April (to June) 5832

P. pulchrum Blume
Herb, stems erect, ascending or decumbent, up to c. 110 cm tall; in moist places marginal to swamps and on river banks, common, also amongst short grasses on planted north-facing sand bank above National Road just south of Mbokodweni River (possibly introduced when bank originally stabilized); flowers throughout year where water available, fewer in July to August, visited elsewhere by beetle and flies for nectar as well as by pollen-eating fly (Syrphidae) 263, 5834

P. salicifolium Willd.
Herb, diffuse, lower stems rooting at intervals, up to c. 90 cm tall; in moist places on river banks or marginal to reed swamps, often extending into shallow water; common; flowers throughout year 1226, 5835, 5863

P. sp. cf. or near *P. salicifolium* Willd.
Diffuse herb, branches slender, decumbent or ascending, up to c. 90 cm tall; in moist sandy soils on river banks often with *P. salicifolium* where water movement free, common; flowers (July to) September to April (to June) 5830

P. senegalense Meisn. forma *albotomentosum* R. Grah.
Robust herb, stems erect or ascending, rooted below, up to 230 cm tall; in moist places, common, especially as early colonizer of bare sandy alluvium deposited on flood-plain following floods; flowers December to May (to June); visited by wasp and elsewhere by small bee ... 272, 5945

CHENOPODIACEAE

Chenopodium album L.
Annual herb, erect, up to 150 cm tall; ruderal; frequent; flowers September to May; eaten by goats and as a cooked vegetable by man 1148, 1211

C. ambrosioides L.
Herb, generally annual, much branched, up to c. 100 cm tall; ruderal; common; flowers August to June (to July) .. 406

C. murale L.
Annual herb, side branches well developed, bushy, up to 60 cm tall; ruderal; occasional; flowers July to April 5254

C. opulifolium Schrad. ex Koch & Ziz
Annual herb, slender, erect, up to c. 170 cm tall; ruderal in reddish sandy soils, disturbed woodland, or in low-lying situations; common; flowers September to April 4927, 5097

Atriplex patula L. subsp. *verreauxii* (Moq.) Aell.
Annual herb, erect, up to c. 150 cm tall, leaves fleshy; in open places at upper tidal limit or just above in and around Sipingo estuary; very common, also at Mbokodweni lagoon where less common; generally dies off from mid-April, seedlings appear late July to August; flowers September to March (to June) 5263, 5273

Chenolea diffusa Thunb.
Perennial, decumbent, diffuse suffruticose herb; leaves fleshy glaucous; in sandy mud and sand at uppermost tidal limit in lagoon and in salt-spray zone on and just above supralittoral rocks; common; flowers April to July .. 244

Arthrocnemum natalense (Bunge ex Ung.-Sternb.) Moss var. *natalense*
Perennial decumbent herb, generally mat-forming, young stems succulent, somewhat woody later; at upper fringe of intertidal zone in lagoon; abundant, often forming

extensive mats on saline flats where covered only at exceptionally high spring tides, also common in shallow moist saline soil on or just above supralittoral rocks; flowers December to February, June, July 273, 4246, 4545, 4870

AMARANTHACEAE

Celosia trigyna L.
Slender suffrutex, often straggling, up to c. 100 cm high, marginal to woodland and forest, often where disturbed, and in salt-spray zone; common; flowers January to July 777, 4864

Amaranthus deflexus L.
Annual low herb, stem erect up to c. 20 cm tall or somewhat decumbent; ruderal in low-lying somewhat moist sandy soil, occasional; flowers (July to) September to February; eaten as cooked vegetable 6294

A. dubius Mart. ex Thell.
Robust annual herb, up to 170 cm tall; ruderal in destroyed dune forest, locally occasional, flowers December to April (to May) 6523

A. gracilis Desf. ex Poir [=*A. viridis* L.]
Annual herb, main stem erect up to 46 cm tall, branches spreading from base, somewhat decumbent, up to 70 cm long; ruderal; common; flowers December to April 4898, 5253, 6297, 6298

A. hybridus L. subsp. *hybridus*
Annual herb, branched from base, bushy, up to 60 cm tall; ruderal in destroyed dune forest, locally occasional, flowers December to April (to May); elsewhere seeds eaten by birds 6524

A. hybridus L. subsp. *incurvatus* (Timeroy ex Gren. & Godr.) Brenan
Annual branched herb, up to 60 cm tall; all parts red; garden escape, usually only in immediate vicinity of place of cultivation; rare; flowers March to April; leaves eaten as cooked vegetable 6533

A. spinosus L.
Robust annual erect branched herb, up to 140 cm tall; ruderal; common; flowers in all months; eaten by Bushbuck and domestic stock; leaves sometimes eaten as cooked vegetable 776, 5106

A. thunbergii Moq.
Annual herb, erect or outer stems somewhat decumbent, up to c. 50 cm tall; ruderal; occasional; flowers October to April; eaten by game; leaves eaten as cooked vegetable ... 5107

Pupalia atropurpurea Moq.
Herb, stems slender, elongated, straggling to scandent, 2-3 m high; in scrub, woodland and marginal to forest, throughout; very common; flowers October to July, visited by ant, bee (for nectar) and wasp; fruits dispersed externally by animals 349, 775

Aerva lanata (L.) Juss.
Suffruticose herb, straggling or semi-scandent up to 100 cm high; in low-lying scrub between hygrophilous grassland and woodland-forest; occasional; flowers September to October 480, 514

Psilotrichum africanum Oliv.
Erect branched herb, rambling or bushy in form (especially where hedged by game) up to 75 cm tall; in woodland and semi-open parts of forest in sandy well-drained soils; frequent; flowers (October to) November to April; eaten by buck 3025, 4862, 4876

Achyranthes aspera L.
Herb, growth-form variable, stems slender erect or leaning up to 210 cm high, or more robust erect up to 120 cm tall; in woodland, generally marginal and where low-lying, and in disturbed places; common; one of hosts of *Cuscuta campestris*; flowers March to June (to July); old perianth parts with mature fruit abscise readily, externally dispersed by animals; fruit eaten by Yellow-eyed Canary. .... 395, 772, 771 (robust form)

Achyropsis leptostachya (E. Mey. ex Meisn.) Hook. f.
Erect well-branched suffrutex, up to c. 120 cm tall; marginal to woodland and forest, also in disturbed areas; common; flowers (November to) February to July, visited by ants, honey bee (for nectar), several wasps and elsewhere by fly (Tachinidae) 765

Brayulinea densa (Willd.) Small
Perennial herb, stems prostrate; ruderal, open places; common; flowers December to June 875

Alternanthera pungens H.B.K.
Prostrate herb; ruderal; common; flowers February to June . 880

A. sessilis (L.) DC.
Weak-stemmed, somewhat diffuse herb, rooting irregularly below, up to 50 cm tall, in moist places, fresh water or slightly saline, generally where disturbed; common; flowers late September to June (to July) 270

Gomphrena celosioides Mart.
Decumbent herb; ruderal; common; flowers September to May 1304

NYCTAGINACEAE

Mirabilis jalapa L.
Branched erect robust herb, up to 120 cm tall, tuberous; in disturbed places, often near dwelling sites; common; flowers August to June; leaves used as poultices by Indians 1260

Commicarpus pentandrus (Burch.) Heim.
Straggling, decumbent herb; in maritime scrub and woodland; locally common; flowers January to May 276

Boerhavia diffusa L. var. *diffusa*
Diffuse, decumbent herb; in disturbed places, often at disturbed margins of woodland or forest; common; flowers September to May; fruit dispersal aided by animals (externally) 586

PHYTOLACCACEAE

Rivina humilis L.
Erect branched suffrutescent herb, up to c. 100 cm tall; in disturbed woodland and in light shade marginal to forest on inland side of main Isipingo Beach Hill and in Mbokodweni Valley; common; flowers September to April (to June); apparently distributed by birds 534

Phytolacca octandra L.
Robust erect branched herb, c. 70 cm tall; in disturbed woodland-scrub on flood-plain of Mbokodweni River, coarse sandy alluvium; locally rare; flowers September to January (locally), visited by small beetle and black ant (*Cremastogaster* sp.); ripe fruit eaten by birds 6283

AIZOACEAE

Limeum viscosum (Gay) Fenzl subsp. *viscosum* var. *kraussii* Friedr.
Procumbent to decumbent herb, apparently annual; in open places, generally where recently disturbed, frequent; flowers September to March 1372

Glinus oppositifolius (L.) A. DC.
Procumbent herb, in moist places where disturbed; common; flowers August to May 604, 1202, 4659

Pharnaceum thunbergii Adamson
Perennial, tap root deep, rootstock woody, stems several

procumbent; in open places, generally where disturbed, in sandy soil on mesocline of main hills extending into upper dwarf salt-spray zone or on bank of Mbokodweni Lagoon; common; flowers September to May 487, 4837, 6051

Tetragonia tetragonoides (Pallas) Kuntze
Straggling fleshy herb; in saline sandy soils, near estuary, lagoons or in dwarf vegetation at base of seaward-facing hills; very common; flowers August to March; leaves cooked as vegetable 134

Aizoon glinoides L.f.
Prostrate herb, generally mat-forming; in open disturbed places, usually where low-lying; frequent; flowers August to June; eaten by game and stock 380

MESEMBRYANTHEMACEAE

Aptenia cordifolia (L.f.) Schwantes
Diffuse succulent herb, sometimes semi-scandent; in estuarine woodland and in dwarf or open vegetation on lower parts of seaward-facing hills; very common; flowers September to July, visited by small bees 135

Carpobrotus dimidiatus (Haw.) L. Bol.
Perennial, stems decumbent, trailing or sometimes somewhat scandent, succulent at first becoming woody later; often forming large mats in short grassland; important sand stabilizer throughout area in all open situations except where moisture excessive; abundant; flowers and fruit at all times of the year, less frequent in winter; leaves eaten by Blue Duiker and possibly by Bushbuck as well; flowers visited mainly by several bees (for pollen and nectar), also by small beetles and butterfly (Lycaenidae); fruit edible; leaves useful for alleviating effects of stings of *Physalia* sp. (Portugese Man-of-War) and other coelenterates 277

PORTULACACEAE

Portulaca oleracea L. var. *oleracea*
Annual, decumbent or prostrate herb; ruderal; common; flowers (July to) September to March; eaten by Bushbuck .. 1363

CARYOPHYLLACEAE

Stellaria media (L.) Vill.
Annual herb, weak-stemmed, 5-15 cm tall, up to 35 cm where supported; ruderal in damp, non-saline places on Isipingo Flats, clayey soils; common; flowers June to December (by late December only in partially shaded damp places, if exposed to sun plants very small in summer or die out completely); elsewhere flowers visited by ant, butterfly (Lycaenidae) and fly (Syrphidae); fruit (seeds) eaten by birds 5853

Krauseola mosambicina (Moss) Pax & K. Hoffm.
Perennial herb, stems erect or decumbent, rooting below, sometimes shallowly rhizomatous, up to c. 35 cm tall; in short vegetation in 'rough' at edge of Golf Course fairways on flood-plain of Mbokodweni River and bank of Mbokodweni Lagoon, sandy soils; locally very common; flowers (December to) January to April, visited by small bee and large black ant; elsewhere readily browsed by game 6052, 6223

Polycarpaea corymbosa (L.) Lam.
Annual herb, erect, up to 40 cm tall; in open scrub, coarse sandy alluvium; very locally common; flowers May 6993

Silene burchellii Otth
Perennial herb, taproot swollen, stems erect or ascending, sometimes straggling, up to 50 cm tall; in open grassland and scrub; common; flowers August to May; roots dug up for medicine 363, 6054

ILLECEBRACEAE

Pollichia campestris Soland. in Ait.
Perennial, much-branched bushy herb, up to c. 60 cm tall; in open scrub and woodland, sandy soils; frequent; flowers (August to) December to April (to June) 1346

Corrigiola littoralis L. subsp. *littoralis* var. *littoralis*
Small herb, taproot long, stems several, decumbent to somewhat erect; early colonizer of alluvial sand banks in Mbokodweni River and other disturbed low-lying sandy places, locally common; flowers September to December 5829

NYMPHAEACEAE

Nymphaea capensis Thunb.
Perennial aquatic herb, rhizome tuberous, laminae floating; in wet mud, periodically inundated or within permanent freshwater, slightly flowing or still; common; flowers September to May (to June), strongly sweet-scented, visited by beetles, flies and bees; fruit, elsewhere, eaten by Purple Gallinule 368, 581

CERATOPHYLLACEAE

Ceratophyllum demersum L.
Herb, stem slender, branched, leaves verticillate, submerged in still or slightly flowing freshwater; common; flowers September, April 920, 4662, 6582

RANUNCULACEAE

Ranunculus multifidus Forsk.
Herb, apparently annual, up to 100 cm tall; in moist, generally open places; very common; flowers September to December (to June), visited by bee 578

MENISPERMACEAE

Cissampelos mucronata A. Rich.
Twining herb in secondary grassland and open scrub, low-lying areas, sandy soil or sometimes in clayey loam; frequent; flowers (November to) December to May 5334

C. torulosa E. Mey. ex Harv.
Stems twining, herbaceous, marginal to or within closed wooded communities throughout; very common; flowers October to January, fruit mature until April 830

Tinospora caffra (Miers) Troupin
Briefly-deciduous climber, somewhat woody; in woodland-forest on north-facing slope above Mbokodweni River, locally occasional; old leaves dropped late June to July, new leaves on young branches July to August; flowers (December to) January; fruits mature February to May 6207

ANNONACEAE

Uvaria caffra E. Mey. ex Sond.
Evergreen shrub, 1 to 2 m tall, frequently scandent up to 6 m or more high, in woodland and forest; very common; flowers not observed locally; fruit mature April to July; host of *Viscum nervosum* 864

Monanthotaxis caffra (Sond.) Verdc. [=*Popowia caffra* (Sond.) Benth.]
Evergreen scandent shrub, 1 to 8 m tall, in woodland and forest, very common; flowers December to January; fruit mature April; parasitized by *Loranthus dregei* and, occasionally, by gall-producing insects 851, 890

LAURACEAE

Cryptocarya latifolia Sond.
Tree, up to c. 7 m tall (stem 12,5 cm d.b.h.), in riparian fringe woodland; locally occasional; flowers February 5305

PAPAVERACEAE

Argemone mexicana L.
Annual herb, erect, up to c. 80 cm tall; ruderal; common; flowers in all months especially July to December, visited by small black bee (for pollen) 13, 5837

A. subfusiformis G.B. Ownb.
Annual herb, erect, up to c. 90 cm tall; ruderal; common; flowers August to December 5838

FUMARIACEAE

Fumaria officinalis L. [=*F. muralis* Sond. ex Koch]
Diffuse annual soft herb; ruderal, generally in fairly moist areas; common; flowers (May to) June to October (to December) 606, 4655

BRASSICACEAE (CRUCIFERAE)

Heliophila scandens Harv.
Climbing herb, apparently perennial, in dune scrub and maritime woodland; common; flowers June to August (to September) visited by honey bee (for nectar), wasp, fly and beetle 4652

H. subulata Burch. ex DC.
Erect herb, up to c. 65 cm tall, sometimes leaning; in open grassland and open scrub; very common; flowers in all months, especially in spring 298, 550, 4546

Lepidium bonariense L.
Annual herb, erect, up to c. 60 cm tall; ruderal; very common; flowers in all months especially August to May .. 2, 6300

L. virginicum L.
Annual herb, erect, up to c. 60 cm tall; ruderal; common; flowers in all months 6299

Coronopus didymus (L.) Sm.
Annual herb, prostrate (or decumbent), occasionally, if with fast-growing low herbs, stem may be erect at first up to 20 cm tall and then horizontal; in disturbed moist open places; common; flowers July to January 467, 4657

Sisymbrium capense Thunb.
Annual herb, erect, up to c. 50 cm tall; ruderal in loamy clay at edge of sugar-cane field on low mesoclinal bank of Sipingo River above tidal influence, very locally frequent; flowers September to January 5854, 5944

S. thellungii O.E. Schulz
Annual herb, erect, up to c. 50 cm tall, ruderal on Isipingo Flats, generally in low-lying places, soils somewhat clayey; common; flowers September 508, 5859, 5867

Rorippa nasturtium-aquaticum (L.) Hayek
Decumbent herb, generally rooting below; in moist sandy alluvium on lower banks of Mbokodweni River, occasional; flowers September to November . 1224, 6284

CAPPARACEAE

Cleome monophylla L.
Erect, branched, annual herb, up to c. 60 cm tall; in disturbed, generally somewhat moist places; frequent; flowers September to April 987, 6215

Capparis brassii DC.
Slender liane in forest and woodland; common; flowers May to August; fruit mature until October 359, 915, 1017

C. fascicularis DC. var. *zeyheri* (Turcz.) Toelk. [=*C. zeyheri* Turcz.]
Liane in woodland and forest; common; flowers January to March 4827, 4878, 4879

C. sepiara L. var. *citrifolia* (Lam.) Toelk. [=*C. citrifolia* Lam.]
Liane in woodland and forest throughout; common; flowers December 1262, 4249, 4891

C. tomentosa Lam.
Robust liane, stem up to 9 cm diameter at 1,5 m from base, in woodland on north-facing slope above Mbokodweni River; common; flowers (June to) July to December (to January); elsewhere plants well-browsed and mature fruit eaten by Vervet Monkey and birds 6699

Maerua nervosa (Hochst.) Oliv.
Shrub, up to 2 m tall; marginal to forest, in maritime woodland and in dwarf scrub at base of seaward-facing hills; common; flowers (May to) June to July (to August) 362

M. racemulosa (A. DC.) Gilg & Ben.
Shrub, up to 120 cm tall, in forest on upper Donsagolo ridge; frequent; flowers not seen locally; elsewhere July to August; fruit mature October 3754

CRASSULACEAE

Kalanchoe pinnata (Lam.) Pers.
Robust, succulent herb up to 120 cm tall, in low-lying grassland just above mangroves; localized - probably left by receding earlier flood waters; flowers August to September 474

K. rotundifolia (Haw.) Harv. var. *genuina* (Haw.) Raym.-Hamet
Erect herb, up to 100 cm tall, in light shade or in open situations; common, particularly near lagoons and in dwarf salt-spray zone, especially where soil shallow on rocks and where somewhat protected from direct effect of southerly to south-westerly winds; flowers (January to) May to July (to August); visited by butterfly (Pieridae) 1, 282

Crassula lineolata Soland.
Slender succulent herb, c. 15 cm tall, in dwarf salt-spray zone at base of seaward-facing hills; occasional; flowers March to May 4972

C. sp. cf. *C. natalensis* Schonl.
Succulent herb up to c. 45 cm tall, in dwarf salt-spray zone at base of seaward-facing hills also in open scrub near Mbokodweni Lagoon; sandy soil; common; flowers March to May (to July) 278, 4923

C. sarmentosa Harv.
Diffuse, trailing, semi-scandent herb, in light shade in scrub and marginal to and within woodland and woodland-forest, low-lying areas; common; flowers March to May (to July) 321, 6228

ROSACEAE

Rubus rigidus Sm.
Shrub, stem slender, trailing, in open scrub and marginal to woodland-forest on Isipingo Flats; common; flowers (May to) August to early December; fruit follows flowers, mature to January; flowers visited by honey bee (for nectar); fruit eaten by man and, apparently, birds ... 517

Rosa sp. cf. *R. odorata* Sweet
Rambling shrub, on railway embankment and fence in well-watered places on western side of Isipingo Flats and in scrub in low-lying parts of old Mlazi flood-plain; locally frequent; flowers September to November .. 5883

LEGUMINOSAE

Albizia adianthifolia (Schumach.) W.F. Wight
Deciduous tree up to c. 11 m tall; heliophyte, invader of grassland, often dominant in woodland seral to forest;

very common throughout except where subjected to direct salt-spray or in well-drained white sandy soils of Isipingo North; leaf loss and gain not only dependent on environmental factors but also on age of specimens, since young plants generally gain new leaves earlier than mature plants in spring and remain in leaf for longer in autumn, leaves dropped (April to) May to July (to August), new leaves produced (end July to) August to September (to October); flowers soon follow leaf production, generally end August to early November; fruits mature in the following winter (late June to August). Note: if conditions in summer are very dry, leaf drop (at least partial) may occur in January or February, with new leaves produced when summer drought broken (February to April); this may be accompanied by flower production, thus two flowering periods and/or two leaf flushes may occur in one year. Flowers visited by butterfly (Pieridae) and wasp; elsewhere seeds eaten by birds; bark often removed by herbalists 475

Acacia karroo Hayne

Deciduous small tree, generally 4-5 m tall but measured up to 10 m tall (stem 25 cm d.b.h.), in open scrub or woodland, low-lying areas; locally common; leaf loss often very brief, new leaves produced August to September, sometimes at same time as loss of old leaves; flowers December to February (to March); fruits mature April to August; plants browsed by stock and game; petiolar glands on young leaves visited by ants; elsewhere, gum eaten by Vervet Monkey; flowers visited by beetles, ants and honey bee (for pollen); fruit eaten by birds and mammals; bark stripped for tying firewood 650

A. kraussiana Meisn. ex Benth.

Semi-deciduous liane in tree-dominated communities throughout; abundant; new leaves generally produced later than in other deciduous plants and sometimes old leaves not lost; flowers December to February (to March); fruit mature May to August (to December); flowers visited by bees, wasp and butterflies (Lycaenidae) 660

A. mearnsii De Wild.

Tree, up to c. 7 m tall, locally evergreen, in secondary scrub near former course of Mlazi River, probably originally brought by floods during the 1940's; rare; flowers not observed locally 5561

A. nilotica (L.) Willd. ex Del. subsp. *kraussiana* (Benth.) Brenan

Deciduous tree, largest measured 3,5 m tall (stem 35 cm d.b.h.), crown spread 7 m x 8 m diameter; in woodland on flood-plains of main rivers, in sandy alluvium; locally frequent; leaves produced before flowers; flowers November to February; fruit mature May to July; elsewhere twigs, leaves and fruit eaten by various mammals 4832

A. robusta Burch. subsp. *clavigera* (E. Mey.) Brenan

Deciduous to semi-deciduous tree, largest measured 11,5 m tall, (stem 50 cm d.b.h.), in woodland and woodland-forest throughout, especially in low-lying areas, early invader of low-lying grassland; very common; flowers produced before, after or, more generally, with new leaves, earliest of local *Acacia* spp. to flower after winter, flowers July to early October; fruit mature in following winter, often still present with flowers; leaves and distal shoots eaten by Bushbuck; flowers visited by honey bee and butterflies; elsewhere seeds eaten from mature pod by Forest Weaver; bark sometimes used for fibre 486, 4668

A. saligna (Labill.) Wendl. [=*A. cyanophylla* Lindl.]

Tree, 6,5 m tall (stem 18 cm d.b.h.), phyllodes evergreen, in open grassland on Isipingo Flats, only one observed (no local spread although spreading in other places within the Durban district); flowers September to October ... 5888

A. sieberana DC. var. *woodii* (Burtt-Davy) Keay & Brenan

Deciduous tree, up to 4,6 m tall, in woodland on north-facing slope above Mbokodweni River and on Isipingo Flats; occasional; flowers December, elsewhere visited by beetles, bees, wasps, drone fly, butterflies and thrips 1371

A. tortilis (Forsk.) Hayne subsp. *heteracantha* (Burch.) Brenan

In secondary scrub, former open grassland; only one small sterile specimen (1,4 m tall) encountered, Isipingo North 5235

Leucaena leucocephala (Lam.) De Wit

Slender shrub up to 3,7 m tall; at disturbed roadside margin to woodland; locally frequent; flowers October to May 531

Mimosa pudica L.

Weak-stemmed suffrutex, up to c. 90 cm tall, in scrub on flood-plain of Mbokodweni River and in secondary grassland at western base of Donsagolo Hill; in sandy clay and loamy sand; occasional; flowers (January to) February to March 6212

Dichrostachys cinerea (L.) Wight & Arn. subsp. *nyassana* (Taub.) Brenan

Deciduous shrub, up to 3,5 m tall, generally much shorter, invader of open grassland; common; flowers December to March; leaves and shoots eaten by stock and game .. 740

Entada pursaetha DC.

Massive deciduous liane in woodland on steep south-facing slope above Mbokodweni River; rare, only one recorded (all stems, some over 30 m long, traceable to one original plant); leaves dropped August, new flush late September; flowers not seen locally 5315

E. spicata (E. Mey.) Druce

Briefly-deciduous liane in woodland and woodland-forest; occasional; flowers November to February; fruit mature April to June (to July) 4248, 4863

Tamarindus indica L.

Tree, c. 12 m tall, in secondary woodland at lower western side of main Isipingo Beach hill; two planted originally by man, not spreading; flowers February to April; fruit mature May to June (to July) 5559

Bauhinia tomentosa L.

Deciduous or semi-deciduous shrub, up to 3 m tall, occasionally semi-scandent, in woodland and at forest margins; reddish sandy soils and in low-lying places, not on well-drained white sands of Isipingo North; common; flowers (late December to) January to April, visited by small brown moth and black bee 744

Cassia bicapsularis L.

Perennial shrub, up to 250 cm tall, sometimes semi-scandent up to 400 cm tall, in disturbed areas, generally in originally rich soils; occasional; flowers April to June (to July) . 883

C. didymobotrya Fresen.

Perennial shrub, often tree-like, up to 480 cm tall (largest of three stems 9,5 cm d.b.h.), in disturbed areas, particularly in sandy soils on flood-plains of rivers; common; flowers in all months, least frequent December to February . 882

C. floribunda Cav. [=*C. laevigata* Willd.]

Small shrub, up to 200 cm tall; in scrub on flood-plain of Mbokodweni River, in sandy alluvium; locally common; flowers December to April (to May) 6161

C. hirsuta L.

Suffrutex or small shrub, up to 270 cm tall, in disturbed places, sandy soils, particularly in disturbed scrub on flood-plain of Mbokodweni River; locally common; flowers April to June 6171, 6275

C. mimosoides L.

Annual erect, several stemmed, much branched, 45-75 cm tall; ruderal; frequent, generally at sides of roads; flowers fairly small, deep yellow, March to April (when plants die) 6527

C. occidentalis L.
Robust annual herb, up to 200 cm tall, in disturbed places; frequent; flowers (October to) February to May (to June); leaf glands prominent, visited by several ants and flies 885, 6170

C. plumosa (E. Mey .) Vogel var. *plumosa*
Perennial low bushy suffrutex, up to c. 25 cm tall, often prostrate or almost so, woody rootstock and rooting system well-developed; in grassland and open scrub, sandy soils; common; flowers relatively large, bright yellow (August to) September to January (to February) 555

C. quarrei (Ghesq.) Steyaert
Annual slender erect, generally one-stemmed, branched, 50-150 cm tall; ruderal, common in all open places; flowers relatively small, generally pale yellow, (November to) December to May (to July) 393

Caesalpinia decapetala (Roth.) Alston [=*C. sepiaria* Roxb.]
Scandent shrub or scrambler in scrub marginal to low-lying woodland; rare; flowers (May to) June to October, elsewhere visited by Collared Sunbird (teste R. Sprawson) 908

Baphia racemosa (Hochst.) Bak.
Evergreen tree, up to 7,6 m tall, in woodland and forest, throughout; common; flowers October to December (to January); fruit mature February to April; one of hosts of *Loranthus dregei* 1234

Dichilus lebeckioides DC.
Much branched herb, decumbent or erect, up to c. 60 cm tall; in disturbed grassland or open places on Isipingo Flats; occasional; flowers October to December 3766, 6316

Crotalaria capensis Jacq.
Shrub, up to 220 cm tall, generally at disturbed margins of woodland or forest; common; flowers February to May, visited by carpenter bee 371

C. grantiana Harv.
Herb, up to 70 cm tall, in open low-lying scrub and grassland; frequent; flowers September to May (to June); eaten by Bushbuck 320, 5635

C. juncea L.
Suffrutex, up to 170 cm tall, amongst secondary grasses in formerly cultivated part of Isipingo Flats, relict of cultivation; occasional; flowers April 5558

C. lanceolata E. Mey.
Annual herb, up to c. 90 cm tall, in open, disturbed places; common; flowers (November to) February to May (to July); inflorescence visited by ant but apparently only for some exudate from pedicel scars of fallen flowers 257, 4840

C. natalitia Meisn.
Suffrutex, up to 150 cm tall, in grassland and open scrub on Isipingo Flats; frequent; flowers (February to) March to July 910, 5636

C. pallida Ait. var. *pallida* [=*C. mucronata* Desv.]
Robust herb, up to c. 75 cm tall, in open scrub invading secondary grassland, sandy soil; locally frequent; flowers February to May (to July) 5356

Medicago hispida Gaertn.
Annual prostrate herb, in disturbed secondary grassland on Isipingo Flats; locally occasional; flowers October to November 3779

Lotus discolor E. Mey.
Procumbent herb, in grassland, low-lying area; frequent; flowers November to December 1208

Indigofera arrecta Hochst. ex A. Rich.
Suffrutex or robust herb, up to c. 220 cm tall, in open scrub and grassland, generally in low-lying areas; common; flowers March to May; roots yield a dye used in colouring woven mats or baskets 863

I. grata E. Mey.
Low bushy suffrutex, up to 60 cm tall, in open grassland, low-lying areas; frequent; flowers February to April 836, 5358

I. inhambanensis Klotzsch
Bushy herb, c. 50 cm tall, in open scrub; locally frequent; flowers February to March 4838, 5332

I. spicata Forsk.
Prostrate herb in disturbed places and short grassland, common; flowers (July to) September to May, elsewhere visited by honey bee (for nectar) and butterfly (Lycaenidae) 381, 576, 791, 4928, 4969

I. trita L. f.
Straggling many-stemmed herb in open grassland; locally common; flowers October to January (to February) . 5285

I. williamsonii (Harv.) N.E. Br.
Suffruticose herb, c. 60 cm tall, in open scrub; locally frequent; flowers January to February 4839, 5554

Tephrosia grandiflora (Ait.) Pers.
Bushy suffrutex, c. 80 cm tall, in disturbed upper flood-plain of Mbokodweni River; coarse sandy alluvium; rare; flowers January to March 6713

T. polystachya E. Mey.
Erect suffruticose herb, up to 110 cm tall, in low-lying grassland marginal to forest or in disturbed somewhat moist places; common; flowers February to March (to May) . 379, 4853

T. purpurea (L.) Pers. subsp. *canescens* (E. Mey.) Brummitt [=*T. canescens* E. Mey.]
Decumbent herb in semi-stablized sand, early dune colonizer; common; flowers January to March 125

Millettia grandis (E. Mey.) Skeels
Semi-deciduous tree up to 6 m tall in woodland in Mbokodweni Valley; locally common; flowers December to February; used for sticks and ornaments 1348

Sesbania bispinosa (Jacq.) W.F. Wight var. *bispinosa*
Annual erect suffrutex, up to 320 cm tall, in low-lying grassland, often where disturbed and generally moist; common; flowers (late January to) February to April (to May) (to September); fruit matures as plants die back, mid-March to July; plants browsed by stock, leaves eaten by beetle larvae 334

S. punicea (Cav.) Benth.
Shrub, up to 250 cm tall, on banks in Sipingo estuary, just above high water ordinary spring tide and on flood-plain and banks of Mbokodweni River, sandy soils, as garden-escape adjacent to human dwellings on Isipingo Flats; locally common; flowers (August to) September to February (to April); mature fruit present until following flowering season 5878

Lessertia sp. cf. *L. harveyana* L. Bolus
Bushy herb, c. 80 cm tall, in moist area in low-lying open grassland; locally common; flowers March to April . 837

Aeschynomene micrantha DC.
Decumbent herb in open grassland and open scrub; common; flowers September to March 1013

A. uniflora E. Mey. var. *uniflora*
Erect suffrutex, up to 240 cm tall, in moist places; common; flowers February to April (to May) 309, 738

Zornia capensis Pers.
Decumbent herb in grassland and open scrub; common; flowers (September to) October to March, visited by carpenter

bee (for nectar) and small black bee (for pollen, without depressing alae) 4834

Desmodium canum (J.F. Gmel.) Schinz & Thell.
Herb, erect up to 60 cm tall, or decumbent, rooting below; in disturbed places, often marginal to forest or woodland; very common; flowers October to May, fruits externally dispersed by animals 584

D. hirtum Guill. & Perr.
Suffruticose herb, stems trailing, in low-lying grassland, generally marginal to moist areas; common; flowers November to March 733

Dalbergia armata E. Mey.
Deciduous liane in woodland and forest throughout; common; often encroaching into grassland; often without leaves for only a very short period, old leaves still present at end of August and new leaves appear early September to end September; flowers (late September to) October to November (to early December); fruit mature (late March to) April to June (to July); browsed by Bushbuck and one of hosts of *Loranthus dregei* 536

D. obovata E. Mey.
Deciduous liane in scrub, woodland and forest throughout; very common, often (in shrub form) invading grassland; leaves dropped June to July, new leaves appear mid July to early September (to October); flowers (late October to) November to December (to February), elsewhere visited by beetles; fruit mature from April to June; leaves and twigs eaten by game; Hemiptera (Coccidae and Membracidae) on stems; stems used in osier work . 1205

Vicia sativa L.
Low herbaceous climber, annual, in semi-open generally disturbed, low-lying places; frequent; flowers September to December 5879

Abrus precatorius L. subsp. *africanus* Verdc.
Semi-scandent or trailing suffrutex, in open grassland and open scrub; common; flowers December to March; fruit mature March onwards, much in evidence as plants die back in winter, often still present until following October .. 1343

Glycine wightii (R. Grah. ex Wight & Arn.) Verdc. [=*G. javanica* L.]
Twining herb in scrub marginal to woodland and forest; common; flowers (October to) March to April (to May); fruit mature April to June; leaves and stems eaten by Bushbuck 138, 831

Erythrina lysistemon Hutch.
Deciduous tree, up to 10 m tall, in scrub, woodland and early forest; common; length of period without leaves very variable, occasionally in well-watered places old leaves dropped and new leaves produced more or less simultaneously, generally leaves dropped late May to June (to July), new leaves produced August to September; flowers while old leaves still present until after new leaves appear (late April to) May to September (to November, rare flowers with full leaf December to January); fruits mature November to January; sometimes defoliated by large unidentified caterpillar; elsewhere visitors to flowers include fly (Calliphoridae: Rhiniinae), honey bee (for pollen and nectar) and several birds including various sunbirds as well as the following taking nectar - Black-eyed Bulbul, Indian Myna, Cape White-eye, Cape Weaver and Yellow Weaver; stems used for fence poles (where they generally strike readily) and bark occasionally removed for medicinal purposes .. 481

Canavalia bonariensis Lindl.
Climbing robust herb in low-lying woodland-forest; frequent; flowers November to May 324

C. maritima (Aubl.) Thouars [=*C. rosea* DC.]
Robust herb, prostrate, long trailing, to semi-scandent, in semi-stabilized and stabilized sand, early colonizer of beach fixed dunes and estuarine banks and in dwarf zone at base of seaward-facing hills; very common; flowers January to May (to June); fruit mature May to July, seeds water dispersed; ant (*Cremastogaster* sp.) visits outside of flowers and glands at base of flowers 319

Rhynchosia caribaea (Jacq.) DC. var. *caribaea*
Twining herb in maritime scrub and open woodland, and marginal to dune forest; frequent; flowers March to April (to May) 128, 6214

R. caribaea (Jacq.) DC. var. *picta* (E. Mey.) Bak. f.
Notwithstanding the placing of this taxon as a *varietas* of *R. caribaea*, in this area this is quite distinct morphologically and ecologically from *R. caribaea* var. *caribaea*.
Herb, stems climbing or trailing, in open scrub and grassland and marginal to closed communities, not subjected to excessive salt-spray; common, particularly in lower-lying areas; flowers (February to) March to May (to August), elsewhere visited by moth, honey bee and carpenter bee 397, 6172

Eriosema parviflorum E. Mey. var. *parviflorum*
Suffruticose herb up to 60 cm tall, stems generally several, spreading, in low-lying grassland; loamy soils; common; flowers September to December 605, 6807

E. psoraleoides (Lam.) G. Don
Suffrutex, up to c. 120 cm tall, in open scrub and grassland; sandy soils; common, in places abundant, especially in low-lying areas; flowers October to December or (February to) mid-March to May 396

E. squarrosum (Thunb.) Walp. var. *squarrosum*
Herb, stems shortly trailing or erect up to c. 50 cm tall, amongst short grasses in low-lying area, relatively high water table; frequent; flowers September to May, visited by bee for nectar 4981, 6811

Vigna luteola (Jacq.) Benth.
Climbing herb, marginal to reed-swamps and in riparian scrub; common; flowers in all months 383, 741

V. unguiculata (L.) Walp.
Decumbent, trailing or low-climbing herb in open scrub and grassland extending into short salt-spray communities; very common; flowers (September to) October to March; elsewhere ant (*Plagiolepis* sp.) visits extra-floral nectaries on swollen rachis of inflorescence 1269, 3780

V. vexillata (L.) A. Rich. *(s.l.)* [=*V. capensis* (Thunb.) Burtt-Davy]
Twining herb in grassland and open scrub in alluvial silty sand and loam on Isipingo Flats; locally frequent; flowers November to March 6526

Lablab purpureus (L.) Sweet subsp. *purpureus* var. *purpureus* [=*L. niger* Medik.]
Twining herb in maritime scrub and woodland; common, occasional in scrub away from maritime influence; flowers (November to) March to May 124, 290

Macrotyloma axillare (E. Mey.) Verdc. var. *axillare* [=*Dolichos axillaris* E. Mey.]
Twining herb in open scrub and grassland, generally somewhat moist places; common; flowers February to April ... 240

GERANIACEAE

Geranium ornithopodum Eckl. & Zeyh.
Much branched, weak-stemmed herb, stems ascending or semi-scandent 30-130 cm high; in moist non-shaded places, frequent; flowers August to October (to December), visited by beetle and several bees (for nectar and pollen) 580

Pelargonium grossularioides (L.) Ait.
Decumbent, mat-forming herb, erect branches up to c. 30 cm tall; in moist places, extending into short grassland just above extreme high water level of tidal lagoon; common,

also ruderal in low-lying open places; flowers September to June, visited by small bee (for nectar); eaten by Bushbuck 466

OXALIDACEAE

Oxalis corniculata L.
Decumbent, creeping slender herb; in open grassland, particularly disturbed areas, and in lawns and sportsfields; common; flowers in all months, not so prolific in June and July; elsewhere flowers visited by honey bee (for nectar) 1364

O. latifolia H.B.K.
Acaulescent herb, leaves and peduncles (up to 25 cm tall) arising from brown scaly bulbs; in disturbed areas; frequent; flowers October to December and May to June; visited by butterflies (Pieridae and *Danaus chrysippus*) and elsewhere by honey bee (for nectar) 974

ERYTHROXYLACEAE

Erythroxylum emarginatum Thonn.
Tree, up to 6 m tall, in woodland and forest, throughout; common; flowers August to October 558

ZYGOPHYLLACEAE

Tribulus terrestris L.
Annual herb, stems prostrate, up to 3,5 m long; ruderal in open, low-lying place; locally frequent; flowers (November to) December to April 6318

RUTACEAE

Fagara capensis Thunb.
Deciduous tree up to 9 m tall, in woodland and forest throughout; common; leaves dropped from June, new produced late September to October; flowers October to November; elsewhere visited by beetle; fruit mature February to May; apparently distributed by birds; bark removed for medicine 535

Teclea gerrardii Verdoorn
Evergreen tree, up to 10,7 m tall (stem 43 cm d.b.h.), in woodland-forest and forest throughout; common; flowers October (to January); fruit mature November to January; seeds apparently bird-distributed; one of hosts of *Loranthus dregei*; elsewhere flowers visited by beetle and Hemiptera; bark removed for medicine 360, 603, 3736, 3737

Clausena anisata (Willd.) Hook. f. ex Benth.
Deciduous small tree, up to 7,6 m tall, in scrub, woodland and forest throughout; common; new leaves produced just before flowers July to September; flowers August to September (to October); fruit mature January to March; apparently distributed by birds; bark removed for medicine 507

BURSERACEAE

Commiphora harveyi (Engl.) Engl.
Deciduous tree, largest measured 10 m tall (stem 56 cm d.b.h.), in scrub, woodland and forest throughout; very common; generally brown outer bark constantly peeling in large thin portions but on mesocline (where also exposed to salt-spray-bearing winds) bole clean, bark not flaky; of all deciduous species in this area this generally has the longest period without leaves although not necessarily earliest to drop leaves (see *Celtis africana*), leaves yellowing and beginning to drop from early March, mostly leafless by end May, (some years not until July), new leaves produced late September to mid-October (or in March following break in summer drought, if severe); flowers November to December; fruits mature February to March; seeds with red aril, eaten by birds, i.a. Black-collared Barbet elsewhere (teste K.L. Tinley); one of hosts of *Loranthus dregei* 848, 1209, 5248

C. woodii Engl.
Deciduous tree, up to c. 10,5 m tall (stem 46 cm d.b.h.), in dune forest; occasional; flowers produced just before or with new leaves, September 510, 1265

MELIACEAE

Turraea floribunda Hochst.
Semi-deciduous tree, up to c. 7 m tall, in woodland and forest throughout; common; old leaves sometimes lost in winter, more generally dropped immediately prior to flower production; flowers just before or with new leaves (August to) October (to November) or, following break in summer drought, in March; coppice browsed by Bushbuck; seeds apparently bird-distributed; one of hosts of *Loranthus dregei*; many specimens with bark removed or roots dug up and cut by herbalists, frequently resulting in eventual death of specimen 378, 551, 961

T. obtusifolia Hochst.
Evergreen shrub, up to c. 1,8 m tall, in woodland and forest, including dwarf salt-spray zone at base of seaward-facing hills, common; flowers in any month; leaves and roots used for medicine elsewhere (no personal evidence of utilization in this area) 19, 129

Melia azedarach L.
Deciduous tree, up to c. 8 m tall, in disturbed places throughout, except where subject to direct salt-spray influence; very common, especially in early riparian woodland; young specimens drop leaves later and produce new leaves earlier than mature fruit-bearing trees; in general, leaves drop (mid-April to) May to July, leafless (mid-May to) mid-June to mid-August, new leaves mid-August to early September; flowers late August to October; fruit mature with leaf loss (April to) May to September (to October) sometimes still present with full production of new season's leaves and flowers; one of hosts of *Loranthus dregei*, often very heavily infested; elsewhere, leaves eaten by cattle and young leaves by Vervet Monkey, fruit eaten by birds (i.a. Black-eyed Bulbul) and by mammals, i.a. captive Steenbuck ate mature fallen fruit but expelled hard part after short period of chewing (probably ate merely dried outer pericarp), also small piles of drupes with outer dried parts chewed seen under *Mangifera indica* (fide H. Baijnath), this suggests that some Fruit Bat also feeds on this fruit; straight stems of saplings used for broom handles 478

Ekebergia capensis Sparrm.
Deciduous tree, up to 10,9 m tall (stem 35 cm d.b.h.), in woodland and woodland-forest; common, not on steep xeroclines or where directly exposed to on-shore winds, or in well-drained white sands of Isipingo North; base sometimes buttressed; leaves lost for short period July to August (to October), new leaves August to October; flowers follow leaf production September to November (to December); fruit mature (December to) January to February; browsed by Bushbuck; flowers visited by fly (Muscidae); fruit eaten by birds; bark sometimes removed for medicine 1222

Trichilia dregeana Sond.
Evergreen tree, up to 15 m tall (stem 64 cm d.b.h.), in woodland and woodland-forest, especially in low-lying areas, loamy sand, not in salt-spray communities or dune forest; frequent; flowers (September to) October to November; fruit mature (March to) April to June; one of hosts of *Loranthus dregei*; elsewhere flowers visited by several butterflies and bee; seeds eaten by birds; bark used for medicine 856

MALPIGHIACEAE

Acridocarpus natalitius A. Juss. var. *natalitius*
Scandent shrub in woodland-forest just above tidal river and on

xerocline of main hills; frequent; flowers April, elsewhere visited by large black ant and beetle 828

POLYGALACEAE

Polygala hottentotta Presl
Erect herb up to c. 80 cm tall, in open grassland and open scrub; sandy soils; common; flowers throughout year 992

P. uncinata E. Mey. ex Meisn. [=*P. rehmannii* Chod.]
In open disturbed place on upper flood-plain of Mbokodweni River, sandy alluvium; rare; flowers September to December (to March) 6282

P. virgata Thunb. var. *decora* (Sond.) Harv.
Slender suffrutex, c. 200 cm tall, in scrub on lower flood-plain of Mbokodweni River, clayey alluvium; rare; flowers March (elsewhere all months) 6211

EUPHORBIACEAE

Phyllanthus burchellii Muell. Arg.
Slender erect herb, 15-80 cm tall, in grassland, generally secondary, and marginal to woodland, often where somewhat moist; common; flowers September to April 787, 5342

P. discoideus (Baill.) Muell. Arg.
Deciduous tree, up to 8,5 m tall (four stems, 15-23 cm d.b.h.), in relict woodland, upper flood-plain of Mbokodweni River, loamy sand; occasional; flowers not recorded locally 6715

Drypetes arguta (Muell. Arg.) Hutch.
Shrub or small tree, generally up to 4,5 m tall, but tallest recorded 6,9 m (stem only 11 cm d.b.h.); in woodland-forest and forest, particularly on xeroclines of main hills; common; flowers October to December; fruit mature April to June 1237

D. natalensis (Harv.) Hutch.
Evergreen tree, up to 9 m tall, in woodland-forest and forest; common; cauliflorous, flowers late August to February; fruit mature January to May, edible and eaten apparently by bat and/or bird as well as by Vervet Monkey 358, 1362

Antidesma venosum E. Mey. ex Tul
Deciduous tree, up to 9,1 m tall (stem 48 cm d.b.h.), in woodland or woodland-forest, not where too dry nor where exposed to direct salt-spray; common; individual complete leaf loss for about only two weeks, yellowing and dropping (June to) July to August (to October), new leaves produced September to October; flowers December to January (to February); fruit mature February to April (to May); elsewhere flowers visited by fly (Muscidae), honey bee and wasp; fruit eaten by several birds and man 1339, 1340

Bridelia micrantha (Hochst.) Baill.
Deciduous tree, up to 11,3 m tall (stem 46 cm d.b.h.), in woodland in low-lying parts and on mesocline where not directly influenced by salt-spray; common; leaves yellowing mid-April onwards, deepening to red late May to August; new leaves produced late August to September (to early October); flowers October to November; fruit mature January to March (to April), eaten by birds; bark removed for medicine 891

Croton sylvaticus Hochst. ex Krauss
Deciduous or semi-deciduous tree, up to 9 m tall, in woodland in Mbokodweni Valley and southwards; locally common; leaves yellow and begin to drop from (February to) late March, often still many with old leaf until end August to September (to early October), new leaves produced, often while some old leaves still present, (mid-August to) September to October (to early November) but if mid-summer drought leaves drop earlier and new leaves produced during February to March, sometimes followed by flowers; flowers, after new leaf production, (September to) October to December (to January); fruit mature (December to) January to April (to May); one of hosts of *Loranthus dregei*; distal branches frequently infested with froghopper larvae (Hemiptera-Cercopidae); flowers visited by beetle, various flies (including Muscidae, Syrphidae, and Tachinidae), honey bee (for nectar and pollen) and moth; fruit eaten by birds; bark removed for medicine 1338

Acalypha ecklonii Baill.
Herb, bushy, stems erect or ascending, up to c. 50 cm tall, in loam or loamy sand; in moist places, often where previously disturbed; flowers (July to) October to February 592, 5349

A. glabrata Thunb.
Shrub, up to c. 3 m tall, in open woodland and marginal to forest on inland-facing hills, slightly loamy reddish sands; common; shortly deciduous, new leaves late August to September; flowers (September to) October to April (to May); browsed by stock and game; visited by carpenter bee and honey bee 242, 4867

A. petiolaris Hochst.
Diffuse low suffrutex in open grassland, sandy soils; common; flowers (August to) September to March; one of hosts of *Thesium asterias* plants sometimes excavated for roots by herbalists 505

A. sonderiana Muell. Arg.
Deciduous shrub or small tree, up to 4,6 m tall, in woodland-forest on inland slopes of hills, reddish sandy soils; frequent; leaves yellowing and dropping from mid-June onwards, new leaves produced mid-September to October; flowers, just before and with new leaf production, September to October 773, 986

Tragia durbanensis Kuntze
Twining herb in scrub, woodland and forest margins throughout; very common; flowers (September to) November to April; elsewhere eaten by Bushbuck, seeds probably distributed by birds 588

Ctenomeria capensis (Thunb.) Harv. ex Sond.
Twining herb in scrub, woodland and open parts in forest; common; flowers October to April 1353

Dalechampia capensis Spreng. f.
Twining herb in scrub, woodland and forest margins throughout; common; flowers December to April, visited by small bee (for pollen) 239

Ricinus communis L.
Soft-wooded shrub or tree in disturbed areas; very common, particularly in soils with humus and in riverbank vegetation where up to 8,2 m tall (two stems 16 cm, 9 cm d.b.h.); flowers and fruit in all months; male flowers visited by honey bee (for pollen) and both sexes by large black ant; extra-floral nectaries on leaves and at bases of inflorescence branches visited by Cape White-eye and ants, elsewhere by fly; browsed by Bushbuck and stock 781

Suregada africana (Sond.) Kuntze
Evergreen shrub or small tree, up to 4,3 m tall, in dune forest; common; flowers not recorded locally 997

Sapium integerrimum (Hochst.) J. Léon.
Briefly-deciduous tree, up to 7,6 m tall, in open woodland and woodland-forest throughout; common; old leaves dropped and new leaves produced more or less simultaneously (July to) August to October; flowers generally with new leaves August to October; fruits mature April onwards, frequently still some present when old leaves fall and new season's flowers produced; scale-insect (Coccidae) sometimes infests stems of juveniles; browsed by Bushbuck; elsewhere flowers visited by wasp and fly (Syrphidae) and glands at base of male branches of inflorescence visited by large black ant and small fly;

elsewhere, fallen fruit eaten by doves (teste T.B. Oatley) 888, 959

Euphorbia chamaesyce L. [=*E. prostrata* Ait.]

Prostrate to semi-prostrate small herb in open disturbed places; very common; flowers in all months, elsewhere visited by small ants 784, 1297

E. geniculata Orteg.

Erect branched herb, up to 50 cm tall, in open disturbed scrub and forest margin not exposed to on-shore winds; locally frequent; flowers at all times of the year, visited by ant and wasp 5898

E. heterophylla L.

Erect branched herb, up to 140 cm tall, in disturbed places; locally common; flowers August to June visited by butterflies, fly, honey bee (for nectar and pollen), ant and wasps; elsewhere eaten by Bushbuck (fide T.B. Oatley) 767

E. hirta L.

Low herb, procumbent to somewhat erect, up to 30 cm tall, in disturbed places; very common; flowers throughout year, visited by ants and, elsewhere by butterfly (*Danaus chrysippus*) 780, 785

E. hypericifolia L.

Much branched herb, up to 60 cm tall, in open disturbed places, especially roadsides; common; flowers throughout year 4858, 4883

E. inaequilatera Sond.

Prostrate, mat-forming herb in open disturbed places; common, flowers September to April 468, 1296

E. ingens E. Mey. ex Boiss.

Tree, largest measured approximately 9 m tall (stem 53 cm d.b.h.); in forest on well-drained soils; frequent; flowers March to May (to June); fruits mature (May to) June to August (to September); elsewhere flowers visited by several flies, especially Tachinidae 833

E. kraussiana Bernh.

Robust erect herb, sparingly branched, up to 75 cm tall, in low-lying woodland; locally common; flowers September to April 968

E. livida E. Mey. ex Boiss.

Prostrate or ascending herb in shallow sandy soil on and just above supralittoral rocks, also more or less erect up to 20 cm tall, where protected from strong winds, as in sand at upper tidal limit of Mbokodweni Lagoon adjacent to beach; very common, important in early stages of lithosere; flowers throughout year 133

E. tirucalli L.

Tree, up to c. 5 m tall, in woodland south of Mbokodweni River; locally frequent, probably relict of long-disused kraal sites; flowers September to October, elsewhere visited by various Hymenoptera, including honey bee (for pollen) and few flies; commonly planted near traditional Black homes 1341

ANACARDIACEAE

Sclerocarya caffra Sond.

Deciduous tree in woodland or at forest margins; frequent; largest measured 10,3 m tall, (stems three from near base, 19 cm, 28 cm, and 46 cm d.b.h.); stunted or deformed where exposed to on-shore winds, even if light; generally leafless (June to) July to September (to October), new leaves produced (late September to) October; flowers with new leaves late September to October (to early November); fruit mature March to May; flowers visited by ant, honey bee (for pollen) and fly (Muscidae), fruit eaten by several mammals including cattle and man; bark often removed for medicine 1253, 3741, 5255, 5256, 5257

Protorhus longifolia (Bernh.) Engl.

Evergreen tree, up to 10,7 m tall in woodland and woodland-forest; forest precursor, particularly in low-lying grassland or lightly shaded places and where protected from fires, not in well-drained white sands of Isipingo North; very common; flowers August to September; fruit mature October to December, eaten by Vervet Monkey elsewhere (teste J.D. Ward), various birds and possibly fruit bat; bark frequently removed for medicine 477, 491

Schinus terebinthifolius Raddi

Shrub, up to 8,9 m tall planted as hedge, escaped in places and invading secondary grassland on Isipingo Flats; locally common; flowers March to April; fruit mature May to August, flowers visited by many insects including Hemiptera, several flies, honey bee (for pollen) and several wasps; fruit eaten by birds (i.a. Black-eyed Bulbul and Cape White-eye) 5557

Rhus chirindensis Bak. f. forma *legatii* (Schonl.) R. & A. Fernandes

Deciduous tree, up to 10,5 m tall, in woodland and woodland-forest; common; leaves yellowing and dropped (end May to) June onwards, generally some still present when new leaves produced September to October; flowers (October to) November to January; fruit mature February to May; elsewhere flowers visited by wasp and honey bee. 844, 1005

R. natalensis Bernh.

Scandent shrub, up to c. 5 m high, in woodland and in short forest; common; very briefly deciduous, old leaves dropped simultaneously with new leaf production in October; flowers October to November; fruit mature December to March (to April); partial flush of new leaves and flowers may occur in March following break in severe summer drought 490, 4920

R. nebulosa Schonl.

Scandent shrub, briefly deciduous, in all habitats except excessively wet situations; very common; new leaves July to August, flowers March to May; fruit mature May to July; seeds apparently bird-distributed .. 255, 867, 4917

R. rehmanniana Engl.

Deciduous shrub up to 2,5 m tall, in low-lying open woodland and scrub; frequent; flowers March to April; fruit mature April to May; eaten by birds and man 4894

CELASTRACEAE
(incl. HIPPOCRATEACEAE)

Maytenus nemorosa (Eckl. & Zeyh.) Marais

Armed shrub, up to 6,4 m tall, in dune scrub, woodland and forest, also in low-lying scrub and woodland just above tidal river; very common; spines prominent, measured up to 267 mm long; flowers (February to) April to July (to September).................. 247, 559, 866, 4251, 5308

M. peduncularis (Sond.) Loes.

Small tree, only juveniles recorded (up to 2 m tall), in woodland on steep mesocline of Jeffels' Hill, slightly clayey, red sands; occasional 5312, 5815

M. procumbens (L. f.) Loes.

Shrub, extremely dwarfed, semi-prostrate where salt-spray excessive but where protected up to 6,7 m tall, in dune and estuarine scrub, woodland and early forest, also on or above supralittoral rocks; very common; flowers April to July; one of hosts of *Loranthus quinquenervis* 249, 318, 860, 4250

Putterlickia verrucosa (E. Mey. ex Sond.) Szyszyl.

Slender shrub up to c. 2 m tall, in woodland, woodland-forest and dune forest; common; flowers October to November 372, 545, 5324

Cassine papillosa (Hochst.) Kuntze
Shrub or slender tree, up to c. 6 m tall, in dune scrub and woodland; common; flowers not seen locally; bark much removed by herbalists 6604

Allocassine laurifolia (Harv.) Robson [=*Cassine laurifolium* (Harv.) Davison]
Scandent shrub or liane in woodland-forest and forest; common; flowers October to January 862, 1200, 5952

Salacia kraussii (Harv.) Harv.
Shrublet, up to c. 60 cm tall, in open low-lying grassland, sandy soils; frequent; flowers October, elsewhere visited by large black ant; fruit mature February to March, edible . 593

ICACINACEAE

Apodytes dimidiata E. Mey. ex Arn. subsp. *dimidiata*
Evergreen tree, up to c. 9 m tall, in all habitats except within water, forest precursor; very common; flowers (January to) February (to March); fruit mature April to June, eaten by birds and possibly fruit bat; one of hosts of *Loranthus dregei*; bark sometimes removed for medicine 316, 656, 746

Pyrenacantha scandens Planch. ex Harv.
Climber, stems herbaceous, common throughout except in very wet situations; flowers April 840, 852

SAPINDACEAE

Cardiospermum grandiflorum Swartz
Robust herbaceous climber, in disturbed areas, particularly low-lying places; common; flowers (October to) January to July (to August), elsewhere visited by Hemiptera, bees and wasp 783, 6220

C. halicacabum L. var. *microcarpum* (Kunth) Blume
Herb, stems low-scandent or trailing, in low-lying disturbed place, in loamy clay; occasional; flowers January to April 6216

Allophylus melanocarpus (Sond.) Radlk.
Briefly-deciduous slender tree, up to 5,5 m tall, in woodland, away from direct maritime influence, in reddish sandy soils and on river banks; frequent; old leaves dropped and new leaves produced more or less simultaneously, August to September; flowers February (to March); fruit mature April 658, 5306

A. natalensis (Sond.) De Wint.
Evergreen tree, up to 10 m tall (stem 27 cm d.b.h.), generally shorter, in all wooded communities except dense forest, unless as a relict if canopy short enough; very common; flowers (March to) April (to early May); fruit mature (June to) July to August (to September), eaten by various birds and man; elsewhere coppice shoots eaten by Bushbuck, and flowers visited by bees (for pollen and nectar) and butterfly (*Acraea* sp.) 405

Deinbollia oblongifolia (E. Mey. ex Arn.) Radlk.
Briefly-deciduous shrub or small tree, up to 6,7 m tall, forest precursor, not tolerant of deep shade, very common throughout, not in dwarf salt-spray zone; old leaves dropped and new produced almost simultaneously, end September to early October; flowers mid-March to May (to June); fruit mature August to September (to October); one of hosts of *Loranthus kraussianus*; elsewhere browsed by game and flowers visited by large number of insects - Coleoptera, Hemiptera, Diptera, Lepidoptera (Lycaenidae, Acraeidae and both diurnal and nocturnal moths), Hymenoptera (ants, bees, including honey bee, and several wasps) and thrips; fruit eaten by birds, Vervet Monkey and man 388

Hippobromus pauciflorus (L. f.) Radlk.
Small shrub, c. 1 m tall, at inland, grassland margin of dune forest; locally occasional; no flowers observed locally 5234

MELIANTHACEAE

Bersama lucens (Hochst.) Szyszyl.
Tree up to c. 8 m tall, forest precursor; common, often invading grassland especially in low-lying areas and where protected from fire; flowers January to May; fruit mature July to August, apparently eaten by birds and/or bats 12, 146, 6169

RHAMNACEAE

Ziziphus mucronata Willd.
Deciduous or more frequently semi-deciduous tree, up to 12,2 m tall (stem 43 cm d.b.h.), in woodland and forest on well-drained soils; common; leaves seldom dropped entirely before new leaves produced September to October, or if leafless, this usually late August to September; flowers November to December (to February); fruit mature March to July (to August); one of hosts of *Loranthus dregei*; elsewhere leaves and young twigs eaten by game and flowers visited by various flies, ant, bee, wasp, beetle and bug; fruit eaten by birds and various mammals including man 834

Scutia myrtina (Burm. f.) Kurz
Scandent shrub, rarely non-scandent, if so up to 3 m tall, in all habitats except within water; abundant, especially where dune forest disturbed, or as grassland invader; flowers January to April (to May); fruits April to August; elsewhere browsed by game; flowers visited by butterfly (Lycaenidae), ants, bees (for nectar), several wasps, flies and beetles; fruit eaten by various birds and mammals including man and, elsewhere, Bushbaby (*Galago crassicaudatus* E. Geoffroy) 365

VITACEAE

Rhoicissus digitata (L.f.) Gilg & Brandt
Climbing tuberous shrub, stems often very long, in all non-aquatic habitats; very common, particularly in maritime scrub and woodland; flowers February to April (to May); fruit mature April to September; flowers visited by honey bee (for nectar) and wasps 356, 873

R. rhomboidea (E. Mey. ex Harv.) Planch.
Climbing shrub, stems generally very long, in woodland forest and forest, throughout; very common; flowers December to March; fruit mature February to April . 355, 653, 825

R. tomentosa (Lam.) Wild & Drummond
Climbing tuberous shrub, stems generally very long, in woodland and forest, throughout; common; flowers November; elsewhere fruit mature January to April, July; elsewhere tuber, leaves and fruit eaten by various mammals, fruit also eaten by birds and man 1245

Cissus fragilis E. Mey.
Slender climbing shrub, rootstock large tuber, in woodland and forest, throughout; very common; flowers January to April; fruit mature April to May; flowers visited by wasp; seeds apparently bird-distributed 350, 868

Cyphostemma flaviflorum (Sprague) Descoigns
Somewhat fleshy climbing shrub, in lighter parts of dune forest and in woodland and scrub, generally where influenced by on-shore winds, including dwarf salt-spray zone at base of seaward-facing hills; common; flowers October to June (to August); fruit mature February to September; beetle larvae sometimes in central stem; flowers visited by large black ant; fruit eaten by birds . 245, 370, 858, 6799

C. hypoleucum (Harv.) Descoigns ex Wild & Drumm.
Climbing shrub, stems long robust below and characteristically double-barrelled, in thicket, woodland and forest throughout except where salt-spray excessive; very common; flowers (October to) November to May (to June); fruit mature February to September; flowers visited by fly, large black ant and honey bee (for nectar); apparently bird-distributed 6800, 6801

TILIACEAE

Corchorus trilocularis L.
Erect branched annual herb, up to 70 cm tall, in open disturbed places, low-lying; occasional; flowers January to July; browsed by Bushbuck 329

Grewia caffra Meisn.
Deciduous or semi-deciduous scandent shrub, often markedly lianous, in all non-aquatic habitats except in dense parts of mature forest; forest precursor; very common; leaves yellow and begin to drop June, leafless July to September (to October) (unless winter rain), new leaves (July to) late August to early October, or some in March following rains after severe summer drought; flowers (late November to) January to March; fruit mature March to June (to July), eaten by birds 646

G. occidentalis L.
Deciduous or semi-deciduous scandent shrub in all non-aquatic habitats except where salt-spray excessive and in dense parts of forest; forest precursor; very common; leafless period variable, occasionally leaves lost at same time as new leaves produced or may yellow and drop from May, leafless until September (unless winter rains), new leaves (July to) September, or some in March following rains after severe summer drought; flowers (August to) September to May (to June); elsewhere visited by ants, wasp, various bees and butterfly; one of hosts of *Loranthus dregei* and *L. kraussianus* 464, 532

Triumfetta pilosa Roth. var. *effusa* (E. Mey. ex Harv.) Wild
Suffrutex, up to 150 cm tall, in scrub and grassland, generally low-lying moist areas, often where disturbed; common; flowers February to May (to July); fruit mature April to July, externally distributed by animals; stems die back to base or merely distally June to July 260, 4854

T. rhomboidea Jacq.
Herb apparently sometimes annual but generally dies back only to perennial base, or partly so, up to c. 75 cm tall, in disturbed areas throughout; common; aerial parts die back June to August; flowers (December to) March to May (to July), (October); fruit mature April to August externally distributed by animals; leaves and stems eaten by Bushbuck; flowers visited by honey bee (for pollen and nectar) and carpenter bee (for nectar); elsewhere, extra-floral nectaries, on lowermost tooth (or teeth) or leaf and/or on young calyx lobes, visited by ants and wasps 259, 261

MALVACEAE

Abutilon grandiflorum G. Don
Soft-wooded shrub up to c. 180 cm tall in disturbed (opened) woodland in slightly loamy sand; frequent; flowers October to May (to July); weevils common in mature fruit 6303

A. mauritianum (Jacq.) Medic.
Bushy suffrutex c. 140 cm tall in disturbed woodland, generally lightly shaded, loamy sand, common; flowers October to April 6301

A. sonneratianum (Cav.) Sweet
Suffrutex of somewhat variable form, where exposed generally short and branches spreading, where better protected up to c. 70 cm tall; marginal to forest or woodland, often where disturbed, sandy soils; common; flowers throughout year; eaten by Bushbuck 292, 6304

Malvastrum coromandelianum (L.) Garcke
Erect herb, up to c. 110 m tall, in disturbed open places; common ruderal; flowers August to May (to June); elsewhere eaten by various mammals, tortoise, and cooked as a vegetable by man 779

Sida acuta Burm. f.
Erect suffrutex, c. 100 cm tall, in open scrub invading grassland; rare; flowers May 296

S. cordifolia L.
Erect branched suffrutex, up to c. 110 m tall, in disturbed open places; frequent; flowers (February to) March to June; browsed by cattle 4895

S. dregei Burtt Davy
Suffruticose herb, up to c. 80 cm tall, in tall grassland or open scrub, somewhat disturbed; frequent; flowers September to April 6815

S. pseudocordifolia Hochr.
Erect branched suffrutex, up to c. 110 cm tall, in disturbed open places; frequent; flowers March to April 4896

S. rhombifolia L.
Suffruticose herb, up to 100 cm tall, in disturbed places, open or in light shade; common; flowers November to August, visited by beetle and honey bee (for nectar) and elsewhere by butterfly (Pieridae); eaten by stock and Bushbuck 4929, 6600

Pavonia burchellii (DC.) R.A. Dyer [=*P. patens* (Andr.) Chiov.]
Low suffrutex, somewhat spreading, c. 70 m tall, marginal to secondary scrub on road bank; occasional; flowers November to June 6517

P. dregei Garcke
Bushy suffrutex or soft-wooded shrub, up to c. 150 cm tall; in open woodland or marginal to forest, xeroclinal, especially where disturbed; sandy soils; common; flowers February to May (to June), visited by bee (for nectar) and small beetle 291, 6516

Hibiscus aethiopicus L.
Perennial suffruticose herb, 10-15 cm tall, in secondary grassland and open scrub on Isipingo Flats; loamy sand; locally occasional; flowers November to early December .. 5899

H. calyphyllus Cav.
Bushy perennial suffrutex, up to 150 cm tall, in short woodland in low-lying area; locally frequent; flowers in any month, particularly October to May 323, 963

H. cannabinus L.
Annual herb, up to 330 cm tall, in open disturbed generally low-lying places; common; flowers (February to) March to October; elsewhere ants visit extra-floral nectaries on leaf and calyx of bud 285

H. diversifolius Jacq. subsp. *diversifolius*
Shrubby, somewhat rambling, perennial suffrutex, c. 180 m tall, marginal to reed-swamps; common; flowers in all months; elsewhere calycine nectaries, especially of unopened flowers, visited by large black ants 597

H. fuscus Garcke
Robust perennial suffrutex, up to 180 cm tall, marginal to low-lying woodland, sandy soil; occasional; flowers March to August 841

H. pedunculatus L.f.
Perennial herb, erect, up to 80 cm tall, in light shade in woodland-forest, low-lying area; locally common; flowers in all months 829

H. physaloides Guill. & Perr.
Robust branched herb, erect, up to 150 cm tall in disturbed places, especially disturbed woodland on reddish sands; common south of Mbokodweni River; flowers late September to May 6579

H. surattensis L.
Weak-stemmed, scrambling suffrutex in open short vegetation, generally somewhat moist areas; common; flowers March to May (to June to July to) August to October, visited by bee and small fly; browsed by game 816

H. tiliaceus L.
Tree, usually spreading, largest specimen measured c. 9 m tall, stem 60 cm d.b.h., in brackish soils extending down to high water ordinary spring tides, bases may be covered at exceptionally high tides; abundant, in parts dominant immediately above mangroves, also occasional as low trailing shrub in stunted salt-spray zone on seaward-facing hills where somewhat protected from very strong on-shore winds; heliophyte, slow-growing and stunted where soils not well drained and subject to periodic inundation by salt water, fast-growing in well-drained moist soils with minimal saline influence; flowers August to May, particularly December to February, one of hosts of *Loranthus dregei*, often very heavily infested leading to death of limbs; stems used as living fencing posts since they strike readily from cuttings; bark fibrous, used for tying firewood, etc. 9

H. trionum L. (incl. *H. hastaefolius* E. Mey.)
Annual herb, 15 to 180 cm tall, in disturbed places, generally low-lying sandy soils; common; flowers September to June (to July) 55, 582

STERCULIACEAE

Hermannia grandistipula (Buching. ex Hochst.) K. Schum.
Perennial suffruticose herb, stems weak, in mixed secondary grassland and open scrub, on Isipingo Flats, loamy sand; rare; flowers October to February 5336

H. velutina DC.
Shrub, up to 180 cm tall, in open scrub invading secondary grassland on Isipingo Flats and marginal to riparian woodland, loamy sand; frequent; flowers July to October 893, 5889

Cola natalensis Oliv.
Tree, up to 9,8 m tall (stem 33 cm d.b.h.), in dune forest; common; flowers December to March (to April); visited by large black ant 999, 1369

OCHNACEAE

Ochna barbosae Robson
Deciduous tree, up to 7,6 m tall, in woodland-forest on steep inland side of main Isipingo Beach hill, reddish sandy soil; locally common; leaves, especially on flowering twigs, dropped just before flowering, new leaves produced just after flowering; flowers September to early October, often considerably infested by some insect larvae, apparently hymenopteran 1239, 3759, 5887

O. natalitia (Meisn.) Walp.
Shrub or small tree, up to 3,7 m tall, in woodland and forest throughout; common; flowers (July to) August to October (to November); fruit mature September to December, eaten by various birds 361, 465, 3761

VIOLACEAE

Hybanthus parviflorus (L.f.) Baill.
Low spreading suffruticose herb in disturbed secondary grassland, slightly loamy sand; locally occasional; flowers October 6634

FLACOURTIACEAE

Xylotheca kraussiana Hochst.
In woodland on mesocline of Jeffels' Hill; rare; only one juvenile recorded, 120 cm tall, no flowers seen in this particular locality, elsewhere (July to) August to October (to November) 5318

Scolopia zeyheri (Nees) Harv.
Tree, up to c. 11 m tall, in dune forest; common; flowers not seen in this locality, elsewhere January to February, visited by bees, ant, wasp, fly and several beetles .. 1287

Trimeria grandifolia (Hochst.) Warb. [=*T. rotundifolia* (Hochst.) Gilg]
Small tree, up to 4,5 m tall, in woodland-forest, mainly in low-lying areas; common; flowers August to January, visited by fly (Calliphoridae: Rhiniinae) 647

Dovyalis longispina (Harv.) Warb.
Briefly-deciduous shrub or tree, up to 7,6 m tall, in woodland and forest; common all over; spines slender to robust, up to 90 mm long; old leaves dropped during flowering, new leaves start developing immediately; flowers mid-August to early October; fruit mature late September to October, edible 492, 493, 966, 967, 3774

D. rhamnoides (Burch. ex DC.) Burch & Harv.
Shrub up to 3,5 m tall, in scrub, woodland and forest, all over; common; spines slender; flowers September; fruit mature October to November, edible 3773

PASSIFLORACEAE

Adenia gummifera (Harv.) Harms var. *gummifera*
Deciduous soft-wooded liane, stems generally very long, green, in woodland and forest, well-drained soils; common; flowers January (to April); stem used for counteracting withcraft 1351

Passiflora foetida L.
Herb, stems low-scandent or trailing; in disturbed low-lying grassland, loamy sand; occasional; flowers late December to June 6244

ACHARIACEAE

Ceratiosicyos laevis (Thunb.) A. Meeuse
Twining herb at disturbed margin of reed-swamp; locally common; flowers July to March 502

CARICACEAE

Carica papaya L.
Soft-wooded, hollow-stemmed tree, in refuse dumps in open places and relict cultivated places; occasional; flowers January to July; fruit eaten by various birds, Vervet Monkey and man; elsewhere flowers visited by Black Sunbird and flowers and leaves eaten by Speckled Mousebird 5000

CACTACEAE

Hylocereus tricostatus Brit. & Rose
Succulent leafless shrub, pseudo-epiphyte, climbing on shrubs and trees where discarded by man, not spreading; occasional; flowers January to April 4925

Opuntia vulgaris Mill.
Succulent shrub, up to 2,2 m tall, leaves very small, caducous; in disturbed places, mostly on main Isipingo Beach hill; common; flowers October to April (to June); fruit edible 5029

Pereskia aculeata Mill.
Deciduous scandent shrub, garden escape; locally frequent (main Isipingo Beach hill); flowers (March to) April 4926

THYMELAEACEAE

Peddiea africana Harv.
Shrub, up to 3,7 m tall, in closed wooded communities throughout; very common; flowers in any month, especially November to July; fibrous bark used as cord 374

Lasiosiphon meisnerianus Endl.

Shrub, up to 2 m tall, in open scrub on Isipingo Flats, loamy sand; common; flowers October to July; visited by various butterflies, wasp and bee 1003, 4907

Englerodaphne ovalifolia (Meisn.) Phill.

Small shrub in disturbed scrub on flood-plain of Mbokodweni River, in sandy silt, only one seen in this area, too small for flowers; flowers elsewhere December to April .. 6204

Passerina rigida Wikstr.

Shrub, up to 3 m tall, important colonizer of open sandy places; very common, often locally dominant; not tolerant of fire, shade or direct excessive salt-spray; flowers late September to end October; fruit mature November to December (to January); an occasional host of *Loranthus dregei* 549

LECYTHIDACEAE

Barringtonia racemosa (L.) Spreng.

Apart from those deliberately planted on banks of Mbokodweni River, only two specimens recorded: (i) old specimen between fairways of Golf Course on flood-plain of Mbokodweni River, crown periodically cut, up to 6 m tall: (ii) on bank of brackish water channel leading into estuary of former Mlazi River, above high water ordinary spring tide, small tree, 1,8 m tall probably established c. 1959; flowers December to March (to April) 1223

RHIZOPHORACEAE

Rhizophora mucronata Lam.

Evergreen tree, up to 9,3 m tall, in Sipingo estuarine areas from a little below mean high water upwards, least common mangrove; best developed where exposed to sun or only lightly shaded, in moist or poorly drained muds; tolerant of prolonged basal inundation. Stem up to 25 cm d.b.h., tapering to few cm diameter at soil level under moist muddy conditions, supported by aerenchymatous stilt roots arising from stem and branches (adventitious roots recorded from branches 5,3 m above ground on 6,7 m tall tree), where substrate firmer and better aerated, main stem basally slightly enlarged and stilt roots poorly developed; stilt roots enlarged distally after successful contact with substrate, radiating where environmental conditions apparently equal on all sides, developed only on exposed side when specimen marginal to dense established communities on banks of tidal lagoon or river, spread of stilt roots variable (diameter of spread may equal height of tree); subterranean roots aerenchymatous, relatively short, tapering, bearing fine slender absorptive roots. Viviparous; mature seedling one, rarely two, per fruit, up to 336 mm long, generally falls free from fruit, abscission at distal end of elongated exserted cotyledonary tube (cotyledons fused together, remain in fruit) occasionally fruit falls with seedling, hypocotyl up to 303 mm long, warty, distally enlarged (16 - 18 mm broadest diameter), finally tapering, easily penetrates soft mud (even under water of depth greater than suitable for subsequent growth); epicotyl 2-10 mm long; apical bud protected by tightly enwrapped thickened stipules, initially mucilaginous, 24-32 mm long; freshly fallen mature seedling floats horizontally in saline water, where salinity much reduced seedling vertical with plumule emersed due to higher density of distal hypocotyl; self-erectile if not initially upright in mud, due to upward curvature in distal third of hypocotyl following successful rooting; initial roots fibrous, subterminal or more proximal, not terminal. Flowers mainly November to May, visited by small bee, fly, ants and beetle (eating filaments); seedlings fall at various times particularly in April, hypocotyl of fallen seedlings sometimes eaten by crabs, *Sesarma* sp.(p.)........................... 401

Bruguiera gymnorrhiza (L.) Lam.

Evergreen umbrageous tree, up to 11,6 m tall (stem 41 cm d.b.h.), mangrove in Sipingo estuarine areas above approximately mean high water, in mud and sandy mud; abundant particularly where soils moist and salinity reduced, ultimately if not initially dominant in upper intertidal region; not tolerant of fire or of prolonged basal inundation by saline water. Knee-like pneumatophores produced by upward flexing of shallow horizontal aerenchymatous roots; short descending adventitious roots, finger-like, generally produced from shaded base of stem; stem bases much enlarged, generally buttressed, buttresses up to 56 cm deep at stem extending to 80 cm from stem base (maximum recorded basal diameter, including buttresses, 198 cm). Viviparous; mature seedling one, very rarely two, per fruit, generally falls with fruit and persistent calyx, initial abscission at apex of pedicel, seedling later freed due to abscission at base of cotyledons which remain within fruit; hypocotyl up to 173 mm long, cylindrical tapering, (13-) 15-16 (-18) mm broadest diameter, density greater distally; plumule 2-4 mm long, initially protected by persistent fruit, after release from fruit apical bud protected by modified leaves and stipules, first leaves at extreme base of stem (epicotyl not developed) sessile, scale-like, later very broadly ovate approximately 5 mm x 5 mm (cf. *Rhizophora mucronata*, epicotyl prominent, plumule initially protected by stipules); seedling drops directly into mud or erects itself after rooting, initial root terminal, produced with or soon following development of plumule, hypocotyl becomes upright almost from distal extremity; as with *Rhizophora mucronata* freshly fallen mature seedling floats either vertically or horizontally depending upon density of water, but sinks more readily than *R. mucronata* seedling. Flowers in all months, least in June; explosive pollen-release mechanism triggered by visitors from size of larger ants upwards, pollen propelled to c. 250 mm where no air movement, further in wind. Nectar taken by ants, moth, wasp, Olive Sunbird and Vervet Monkey; mites, both pollen-eaters and apparently nectar-feeders very common in flowers; unidentified moth larva sometimes eats pith of hypocotyl of maturing seedling burrowing in from proximal tender part; stems used in construction of huts, bridges and piers; bark used for dyeing and preserving fishing nets and lines; wood used as fuel 1256

Cassipourea gerrardii (Schinz.) Alston

Tree, up to 8 m tall, in dune forest; frequent; flowers not seen locally, elsewhere September to October (to November) 1289

COMBRETACEAE

Combretum bracteosum (Hochst.) Brandis

Shrub, semi-scandent, up to c. 4 m tall, in riparian scrub; occasional: flowers September to October 526

C. kraussii Hochst.

Tree, up to 10,7 m tall (stem 45 cm d.b.h.), in riparian woodland and scrub; frequent; old leaves dropped generally only after new leaves started to develop, August to October (or January to February); flowers October or January to February, visited by butterflies, wasps and beetles and, elsewhere, by honey bee 529, 4830

C. molle R. Br. ex G. Don [=*C. gueinzii* Sond.]

In riparian woodland, Mbokodweni Valley, only one recorded in mapped area; not fully leafless locally, old leaves lost just before and during new flush, October or, following break in severe summer drought, February to March; flowers with new leaves, October; visitors, elsewhere, flies (Muscidae; Calliphoridae), bees (for nectar), wasp, butterflies (Pieridae, Lycaenidae), moths (Noctuidae) and beetles 1349

Quisqualis parviflora Gerrard ex Harv.

Liane in woodland on steep mesocline of Jeffels' Hill; locally frequent; flowers April to May 5313

MYRTACEAE

Psidium guajava L.

Shrub or tree, up to 8,8 m tall (two stems, 18,5 cm and 14,6 cm d.b.h.); in scrub invading grassland, disturbed areas and in early riparian woodland; very common, in parts abundant; old leaves dropped shortly before or, more generally, during production of new leaves August to early October; flowers October to January (to April); fruit mature March to June, eaten by insects, birds, fruit bat, cattle, Vervet Monkey and man; leaves eaten by stock 1344

Eugenia capensis (Eckl. & Zeyh.) Harv. ex Sond.
In sandy soils in more or less open places throughout or relict in closed communities; common; stunted, only a few cm high in dwarf salt-spray zone at base of seaward-facing hills, but where protected up to 8,5 m tall and stem 25 cm d.b.h.; flowers February to March (to May); fruit mature July to September (to October), edible 130

E. natalitia Sond.
Tree, up to 12,2 m tall, (stem 39 cm d.b.h.), in sandy soils in woodland-forest and forest; very common; flowers September to October; fruit mature January 1000

Syzygium cordatum Hochst.
Tree up to 12,2 m tall (stem 95 cm d.b.h.), in riparian scrub and woodland, in loamy sand or loam; common; also solitary specimen recorded from seaward side of crest of upper Donsagolo ridge, former opening in closed forest; evergreen, but new leaves conspicuous in spring, (August to early October); flowers (late September to) October (to November), (January to) February to March (to April); fruit mature late December to February, April to June (to July); elsewhere flowers visited by ant, wasp, fly and moth (*Amata* sp.); fruit eaten by various birds, Vervet Monkey and man 567, 5300

Heteropyxis natalensis Harv.
Deciduous tree, largest measured 5,8 m tall, stems three from near base, all c. 23 cm d.b.h., in open woodland on Isipingo Flats and Mbokodweni Valley, loamy sand; occasional; leaf-drop and flush not observed in this particular locality but in general vicinity new leaves produced early September; flowers February to March 4833

Eucalyptus andreana Naud.
Tree, up to 14,3 m tall (stem 119 cm d.b.h.) specimen c. 50 years old; in woodland in low-lying area between Sipingo and former Mlazi Rivers, originally planted, now locally self-propagated; locally frequent; flowers August to September 5823

E. robusta J.E. Sm.
Tree, up to 19 m tall, originally planted in 1906 as avenue between Isipingo Station and Isipingo Beach and in other places, readily spreading in secondary grassland and scrub where unburnt on Isipingo Flats; frequent 5822

ONAGRACEAE

Ludwigia octovalvis (Jacq.) Raven subsp. *sessiliflora* (Mich.) Raven
Erect branched suffrutex up to c. 120 cm tall, occasionally somewhat scandent, up to 240 cm tall, when partially shaded; in moist generally open places; common; when submerged, stem and roots have considerable development of aerenchyma and slender erect pneumatophores project vertically upwards from shallow radiating roots, such pneumatophores up to 27 cm tall; flowers in all months, visited elsewhere by small butterflies (Lycaenidae and Hesperidae) 394

L. stolonifera (Guill & Perr.) Raven
Perennial herb creeping on wet mud or clayey sand and over freshwater, open places; common; stem procumbent rooted at nodes, adventitious roots vary in form - when water table low, roots ordinary, when immersed in water or growing over surface of water roots relatively short, some act as absorption organs others develop considerable aerenchyma and act as pneumatophores with tips generally upturned and slightly above water level (possibly act as organs of buoyancy as well); pneumatophores generally longest in those plants developed in wet mud and then covered by water in the rainy season (or perhaps developed in shallow water following rains), such pneumatophores measured up to 19 cm long in 9 cm water; side branches also procumbent when pioneering open places with leaves flat (floating if in water) somewhat crowded distally, later branches ascending or erect up to 50 cm high; flowers October to March; elsewhere visited by ant (*Plagiolepis* sp.) and thrips 1270

Oenothera affinis Camb.
Erect, branched herb 75-100 cm tall, in open grassland and disturbed places; sandy soils; common; flowers October to May 602, 3764, 6174, 6178

O. biennis L.
Erect robust herb, up to 150 cm tall, in disturbed places and in low-lying grassland and open scrub, sandy soils; common; flowers December to March 6173

O. indecora Camb.
Herb, apparently annual, in open disturbed places, sandy soils; common; generally leaves in flat rosette at first, flowering stems ascending or erect up to 40-50 cm tall; flowers in all months if conditions suitable, mostly September to April. 6197

O. laciniata Hill
Herb, apparently annual, branched from base, branches ascending up to c. 60 cm high, leaves generally in basal rosette at first especially if in open situation, in disturbed places on Isipingo Flats, loamy sands; common; flowers September to April (to June) 3763

O. rosea L'Hérit. ex Ait.
Annual herb, stem erect single or several from base, up to c. 50 cm tall, in damp clayey soils, low-lying disturbed places on Isipingo Flats; locally frequent; flowers September to November 6796

GUNNERACEAE

Gunnera perpensa L.
Perennial rhizomatous herb, in moist soil of small freshwater swamp on Isipingo Flats; very locally frequent, more common west and north-west of mapped area, from which it appears now (1969) to be absent, due perhaps to drainage although possibly removed for its medicinal value; flowers September 1325

ARALIACEAE

Cussonia nicholsonii Strey
Briefly-deciduous soft-wooded shrub or slender tree up to 7,6 m tall, in woodland and forest, well-drained soils, throughout; common; flowers February to March 258, 821

C. sphaerocephala Strey
Slender deciduous tree, c. 9 m tall, in dune forest; rare; flowers not recorded for this particular locality, but in general vicinity (March to) June to August (to November) .. 506

APIACEAE (UMBELLIFERAE)

Hydrocotyle americana L.
Procumbent herb, stem slender, rooting from nodes, amongst short (mowed) grasses in low-lying situations on Golf Course in Mbokodweni Valley, alluvial clayey sand; common; flowers September to March 6700

H. bonariensis Lam.
Perennial herb, stem procumbent, rooting at nodes, in moist places; very common, in places abundant; flowers August to April, elsewhere visited by large black ant 818

H. verticillata Thunb.
Perennial herb, stem procumbent, rooting at nodes, in moist places and low-lying grassland; common; flowers (July to) August to September 500

Centella coriacea Nannfd.
Procumbent herb, stem rooting at nodes, in moist places and low-lying short grassland, often where disturbed; very common; flowers September to March; one of hosts of *Thesium asterias*; leaves used as remedy for alimentary ulcers 513, 793

Apium graveolens L.
Annual herb, up to 75 cm tall, in moist places, fresh or slightly saline; very common; flowers August to March, visited by ant and wasp 455

A. leptophyllum (Pers.) F. Muell. ex Benth.
Annual slender herb, up to 60 cm tall, in disturbed, particularly low-lying, places; very common; flowers in all months, mostly August to May 335

Heteroptelis suffruticosum (Berg.) Lente [=*Cnidium suffruticosum* Ch. & Sch.]
Herb, apparently perennial, stems erect or decumbent, up to c. 25 cm tall; in open places, or with stunted vegetation, towards base of steep seaward-facing hills, well-drained sandy soils; locally frequent; flowers October to March (to June) 127

MYRSINACEAE

Embelia ruminata (E. Mey. ex A. DC.) Mez
Scandent brittle-stemmed shrub in scrub, woodland and somewhat open parts of forest, throughout; common; flowers October to January (to February) 957, 5321

PRIMULACEAE

Samolus valerandi L.
Herb, possibly perennial, stem erect, up to 60 cm tall; in damp clayey soils in low-lying parts of Isipingo Flats; locally common; flowers September to December 6788

Anagallis arvensis L.
Decumbent, diffuse annual herb, in disturbed somewhat moist places, loamy soils; common; flowers July to January 1301

PLUMBAGINACEAE

Plumbago auriculata Lam.
Brittle-stemmed shrub, scandent or scrambling, in scrub and woodland on inland-facing slopes of main hills, reddish sandy soil; common; flowers September to April (to May), visited by butterflies; commonly used as an ornamental hedge plant 3738

SAPOTACEAE

Sideroxylon inerme L.
Evergreen tree, up to 13,7 m tall (stem 56 cm d.b.h.), in scrub, woodland and forest throughout; common; flowers (October to) January to April (to May); fruit mature February to May (to September), eaten by various birds and, possibly, fruit bat; one of hosts of *Loranthus dregei*; bark used for medicine, wood used for fence posts and boat building 570

Mimusops caffra E. Mey. ex A. DC.
Evergreen tree, in scrub, woodland and forest particularly where subject to on-shore winds, very common, dominant in maritime woodland and early dune forest (only as relict in mature tall dune forest); also acts as forest precursor where protected from fire, not excessively shaded and soil stabilized; stunted, almost creeping, where salt-spray excessive but up to 14,5 m tall (stem 74,5 cm d.b.h.) where protected; flowers (December to) January to April, July to September; fruit mature (August to) September (to October), December to April eaten by various birds, Vervet Monkey and man; one of hosts of *Loranthus dregei*; timber hard, used locally only for posts and fuel 248

M. obovata Sond.
Evergreen tree, up to 9,5 m tall (stem 55 cm d.b.h.), in woodland-forest and forest throughout, common; flowers August to October; fruit mature January to February; bark often removed for medicine 342, 503, 1238

Manilkara discolor (Sond.) J.H. Hemsl. [=*Muriea discolor* (Sond.) Hartog]
Tree, up to 8 m tall (stem 30 cm d.b.h.) or stem up to 58 cm d.b.h. (tree c. 6 m tall), in woodland-forest and forest on Donsagolo Hill, locally common; larger and more plentiful to north-east of mapped area; flowers October to November (to February); one of hosts of *Loranthus dregei*; bark removed for medicine 3734

EBENACEAE

Euclea natalensis A. DC.
Evergreen tree, up to 10,7 m tall (stem 38 cm d.b.h.) in all wooded communities including dwarf salt-spray zone at base of seaward-facing hills; common; flowers (August to) September to October, visited by honey bee; fruit eaten by Vervet Monkey and apparently by birds; one of hosts of *Loranthus dregei*; frequently roots dug up and removed by herbalists 1196, 1216

Diospyros lycioides Desf. subsp. *sericea* (Bernh.) De Wint.
Shrub, up to c. 1,7 m tall, generally marginal to woodland, (slightly) loamy sands, not in well-drained white sands of Isipingo North nor where exposed directly to on-shore winds; common; flowers July to September; elsewhere browsed by Bushbuck, flowers visited by bees, wasp and butterfly (Lycaenidae), fruit eaten by birds and man, roots used as purgative 905

D. natalenis (Harv.) Brenan subsp. *natalensis*
In woodland-forest and forest; common; tallest measured 10,5 m (stem 10 cm d.b.h.), broadest stem 23 cm d.b.h. (tree 7,6 m tall); flowers October to November; fruit mature April to May, (October), eaten by birds 1009

D. villosa (L.) De Wint. var. *villosa*
Briefly-deciduous scandent shrub in woodland on north- to west-facing slopes of main hills, except Isipingo Beach hill, well-drained reddish sandy soil; frequent, also very occasional in scrub on flood-plain of former Mlazi River; flowers (November to) December to January . 1347, 6821

OLEACEAE

Linociera peglerae (C.H. Wr.) Gilg & Schellenb.
Tree up to 11 m tall (stem 32 cm d.b.h.), in dune forest, common, and occasional in low-lying woodland-forest just above tidal river; young leaves pinkish brown to brownish green at first (January); flowers January to March; fruit mature June to July (to September), eaten by birds 1267, 1290

Olea woodiana Knobl.
Tree, up to 12,8 m tall (stem 41 cm d.b.h.), in woodland-forest and forest all over; common; flowers November to December; fruit mature March to April, eaten by birds; bark removed for medicine 399, 649

Jasminum multipartitum Hochst.
Slender scandent shrub, in woodland and open parts of woodland-forest away from direct influence of on-shore winds; common; flowers (July to) August to October; seeds apparently bird-distributed 538

LOGANIACEAE

Strychnos decussata (Pappe) Gilg
Briefly-deciduous tree, up to 14,3 m tall (stem 58 cm d.b.h.) and stem up to 77 cm d.b.h. (tree 13,1 m tall), (N.B. in former specimen, no change in height and increase of only 2,5 cm diameter over nine year period); in woodland-forest and forest on well-drained sandy soils; common; old leaves dropped immediately prior to new leaf production (with flowers); flowers October to November; fruit mature late March to May, eaten by birds 853, 998, 5099

S. henningsii Gilg
Tree, up to 5,2 m tall, in short forest on steep west-facing slope of Isipingo Beach hill; locally frequent; flowers not seen locally, elsewhere October to November 4865

S. madagascariensis Poir. [=*S. innocua* Del. subsp. *gerrardii* (N.E. Br.) Verdoorn]
Briefly-deciduous tree, up to 12,2 m tall (two stems, 67 cm and 51 cm d.b.h.); in woodland and forest throughout, except where salt-spray excessive, best developed in well-drained sandy soils; very common; leaves dropped October to early December, new leaves produced more or less simultaneously or more usually shortly afterwards, just before flowers; new flush of leaves may occur in February to March following rains terminating summer drought (if severe); flowers November to December (to January); fruit mature April to November (to January), eaten by Vervet Monkey and man 351, 4127, 4128, 4129

S. spinosa Lam.
Deciduous small tree, up to 7,6 m tall, mostly much shorter, in scrub and woodland on well-drained sandy soils out of direct salt-spray influence; forest precursor; common; new leaves produced September to October; flowers October; fruit mature July to October; flowers visited by honey bee (for nectar); fruit eaten by Vervet Monkey and man .. 995

S. usambarensis Gilg
Small tree, up to 6,1 m tall (stem 20 cm d.b.h.), in forest on steep inland-facing slope (xerocline) of main hills, reddish sandy soil; locally frequent; flowers not seen locally, fruit mature October, eaten by birds 3757

APOCYNACEAE

Acokanthera oblongifolia (Hochst.) Codd
Evergreen shrub, up to 7,6 m tall, generally smaller, in all closed wooded communities including dwarf salt-spray zone at base of seaward-facing hills; common; flowers September to November; fruit mature September, eaten by bird or/and fruit bat 494

Carissa bispinosa (L.) Desf. ex Brenan var. *acuminata* (E. Mey.) Codd
Small evergreen shrub, rarely semi-scandent, seldom more than 1,5 m tall, but up to c. 4 m high, in closed wooded communities throughout; very common; flowers August to September (to October); fruit mature until February (to March); roots used medicinally 479

C. macrocarpa (Eckl.) A. DC.
Evergreen shrub, up to c. 4,6 m tall, in all open or short communities on sandy soils, in dune scrub and in dwarf salt-spray zone on and above supralittoral rocks, not shade-tolerant; very common; flowers in all months, considerably fewer or absent in July to August; fruit mature November to August; flowers visited by butterfly (*Papilio niraeus lyaeus* Doubleday); fruit eaten by various birds, Vervet Monkey and man; frequently grown as hedge 516

Catharanthus roseus (L.) G. Don
Perennial herb, erect, up to c. 60 cm tall, in disturbed areas; frequent; flowers in all months, especially throughout summer, elsewhere visited by butterfly (*Precis clelia* Cramer); sometimes used as medicine 4892, 4893

Rauvolfia caffra Sond.
Deciduous tree up to 8,5 m tall (stem 26 cm d.b.h.); in disturbed woodland on bank of Mbokodweni River; rare; new leaves produced August to September; flowers September to October, elsewhere visited by wasps, bees, flies and butterflies; fruit eaten by birds; flowers sometimes galled by insect 4831, 6714

ASCLEPIADACEAE

Asclepias physocarpa (E. Mey.) Schltr.
Annual or more usually short-lived perennial, robust, erect herb, up to c. 2 m tall, in open communities in loam or loamy sand, especially where formerly disturbed; very common; flowers in all months, especially August to May; elsewhere browsed by game, leaves and flower parts (especially of buds) eaten by larvae of butterfly (*Danaus chrysippus* Linnaeus), young stems often heavily infested with yellow aphid, flowers visited by adult *Danaus chrysippus*, flies, beetle, large black ant, various bees, several wasps and nocturnal moths, pollinia observed attached to feet of large black ant, large bee, honey bee and three species of wasp 330

Cynanchum ellipticum (Harv.) R.A. Dyer
Twining herb in scrub, woodland and open parts of forest; common, particularly away from excessive salt-spray; flowers April to August, elsewhere visited by flies, bee and wasps 256, 288, 6761

C. natalitium Schltr.
Twining herb in maritime scrub and woodland; frequent; flowers March to May 246

C. obtusifolium L.f.
Twining herb, often trailing, in dwarf salt-spray zone, and scrub and woodland throughout, not on steep xeroclines; very common; flowers February to September, visited by wasps, ants, bees, fly, moth, butterflies (Pieridae) and Hemiptera 279

C. schistoglossum Schltr.
Twining herb marginal to and within reed-swamps and on stream banks, generally with *Phragmites mauritianus* or *P. australis*; very common; flowers February to May; distal stems often heavily infested with yellow aphid 5548, 6217

Sarcostemma viminale (L.) R. Br.
Leafless succulent slender liane, stems twining, in short forest on steep west-facing slope (xerocline) of Isipingo Beach Hill and in thicket on Isipingo Flats locally occasional; flowers not seen locally 3760

Secamone alpinii Schultes
Evergreen slender liane, in maritime scrub and in woodland or forest throughout; common; flowers (October to) November to April (to June) 243, 1252

S. frutescens Decne.
Evergreen slender liane, in short forest on steep northwest-facing slope (xerocline) of Isipingo Beach Hill; locally frequent; flowers November to April 1241

Ceropegia linearis E. Mey. [=*C. caffrorum* Schltr.]
Tuberous perennial twining herb, sparingly branched, stem somewhat succulent, leaves fleshy, in short woodland-forest in low-lying area just above tidal river; locally frequent, rare in woodland on mesocline of Jeffels' Hill; flowers January to February 5311

Tylophora badia (E. Mey.) Schltr. var. *latifolia* N.E. Br.
Perennial, stems herbaceous, twining, on reeds on river bank; locally common; flowers October; distal stems frequently infested with yellow aphid 563

Pergularia daemia (Forsk.) Chiov. [= *P. extensa* (Jacq.) N.E. Br.]
Herbaceous twiner, in disturbed woodland on upper flood-plain and hill south of Mbokodweni River; locally common; flowers (January to) February to April 6198

CONVOLVULACEAE

Cuscuta campestris Yunck.
Low, twining herb, leafless, in open low-lying disturbed grassland, parasitic on *Stenotaphrum secundatum* and various forbs (including *Achyranthes aspera*); rare; flowers and fruit January to February 1368

Dichondra repens J.G. & R. Forst.
Perennial herb, stem prostrate, rooting irregularly at nodes; early colonizer in open places in disturbed woodland and in light shade in scrub and early woodland, sandy soils, lower-lying areas; common; flowers not seen locally, elsewhere August to September 6238

Evolvulus alsinoides (L.) L.
Perennial herb, stems procumbent, spreading; in open secondary scrub in coarse sandy alluvium; rare; flowers March 7607

Jacquemontia tamnifolia (L.) Griseb.
Annual herb, stems twining or trailing, in sandy soil in disturbed places, generally low-lying or somewhat moist; frequent; flowers March to May 338, 859, 6200

Convolvulus farinosus L.
Perennial herb, stems trailing or twining, in low-lying, generally moist, often disturbed places; common; flowers in all months 817, 6236

Hewittia sublobata (L.f.) Kuntze
Perennial herb, stems trailing or twining, in open communities all over, particularly where disturbed; very common; flowers in all months, least prolific June to July, visited by small bee (for pollen) 585

Merremia tridentata (L.) Hall f. subsp. *angustifolia* (Jacq.) Ooststr.
Perennial herb, stems procumbent, trailing, up to 3 m long, in open grassland and open scrub, sandy soil, often where disturbed; frequent; leaf shape and corolla size and colour variable; flowers October to March 988, 6518, 6519

Ipomoea alba L.
Perennial twiner, stems herbaceous, marginal to woodland-forest, in low-lying places near rivers; locally common; flowers October to July 1247

I. cairica (L.) Sweet
Perennial twiner, older stems verrucose; in moist places, throughout; very common; flowers in all months .. 1218

I. congesta R. Br.
Perennial twining herb, in open places in wooded communities, in low-lying grassland and marginal to reed-swamps, often where disturbed; very common; flowers (July to) August to May (to June); nectar taken by Olive Sunbird 340, 347

I. ficifolia Lindl.
Perennial twining herb, in open places in all mesic wooded communities, particularly where subjected to on-shore breezes, including dwarf salt-spray zone at base of seaward-facing hills; very common; flowers (November) March to May; browsed by Bushbuck 4900

I. mauritiana Jacq.
Twining herb, rootstock large tuberous, stems (annual) herbaceous, in woodland-forest and forest on steep xerocline of main hills, reddish sandy soil; locally common; flowers January to March (to April); upper pedicel, immediately below calyx, especially of buds, visited by large ants and fly 3735, 4847

I. pes-caprae (L.) R. Br.
Perennial herb, stems long trailing, up to 22 m long, in open sand where partially stabilised or somewhat moist; common, particularly on beach dunes or estuarine shores; flowers December to March; mature fruit until July, seeds gravity- and wind-distributed on beach as well as by water; flowers visited by bees, including honey bee, although all taking nectar, bodies well covered in pollen 1273

I. plebeia R. Br. subsp. *africana* A. Meeuse
Annual herb, stems low-twining or trailing; in open disturbed low-lying places, sandy soils; common; flowers (July to) August to April 6177, 6199

I. sinensis (Desr.) Choisy subsp. *blepharosepala* (Hochst. ex A. Rich.) Verdc.
Annual herb, stems prostrate or twining; in open disturbed low-lying places, sandy soils; occasional; flowers January to April 6246

I. wightii (Wall.) Choisy
Perennial twining herb, in low-lying moist places with herbaceous vegetation or reeds, or in low scrub; locally common; flowers (January to) March to June (to August), essential organs sometimes eaten by small black beetles 6231

BORAGINACEAE

Cordia caffra Sond.
Deciduous tree up to 12,2 m tall (46 cm d.b.h. of largest of three branches from base) in woodland and forest throughout; common; leaves generally dropped May to June (to August), new leaves produced (July to) August to September; flowers September to October, (March); fruit mature December to January; one of hosts of *Loranthus dregei*; elsewhere browsed by game, including Bushbuck (teste K. Cooper); fruit edible and seed apparently bird-distributed 489, 659, 745

Ehretia rigida (Thunb.) Druce
Deciduous shrub, up to 6 m tall, in woodland on steep inland-facing slope of Donsagolo Hill, reddish slightly clayey sand; common; new leaves produced July to September; flowers July to October, (February); elsewhere browsed by game, including Bushbuck, and flowers visited by beetles, honey bee, wasps, ant and butterflies; fruit edible 3751

Heliotropium amplexicaule Vahl
Decumbent herb, in disturbed places, slightly clayey sand; locally occasional; flowers December to March, elsewhere visited by honey bee (for nectar), wasp, fly, moths and butterflies (Pieridae, Lycaenidae and *Precis clelia* Cramer) 6522

VERBENACEAE

Verbena bonariensis L.
Annual or short-lived perennial robust herb, erect up to 168 cm, rarely to 190 cm, tall, in grassland and open scrub, on Isipingo Flats, loamy sands, generally where disturbed; common; flowers October to April (to June), visited by butterfly, *Danaus chrysippus* and large wasp 1010, 6320

V. brasiliensis Vellozo
Slender erect, branched herb up to c. 90 cm tall, apparently annual, in disturbed places, generally with other secondary herbaceous vegetation on Isipingo Flats, loamy sands or loam; common; flowers November to March 6321

V. tenuisecta Briq.
Decumbent herb rooting from lower branches, in disturbed place in short secondary grassland on Isipingo Flats, loamy sand; very locally rare; flowers August to April 6309

Lantana camara L.

Much branched shrub, erect, straggling or scandent, in all open communities (or relict in early closed communities where scandent) except early beach dunes, in direct salt-spray, or where excessively moist; abundant, particularly in formerly disturbed places; important forest precursor and protector of forest margins from grassland fires; flowers in all months, especially September to December and March to May, visited by bees and several butterflies; distal twigs of young plants browsed, apparently by Bushbuck; ripe fruit eaten by birds, Vervet Monkey, possibly fruit bat, fly (Drosophiliidae) and fruit moth (*Egybolis vaillantina* Stol.) 333

Phyla nodiflora (L.) Greene

Decumbent perennial herb, stems rooted at nodes, upright parts 3 to 12 cm tall, in low-lying, generally moist, non-shaded places, fresh or slightly saline; common, in parts abundant; flowers September to June, visited by flies and by honey bee (for nectar) 579

Priva cordifolia (L.f.) Druce var. *abyssinica* (Jaub. & Spach.) Moldenke

Perennial erect herb, up to c. 75 cm tall, in all open established communities, and in disturbed places; common; flowers September to May, visited by butterfly (*Danaus chrysippus*); fruit dispersal aided by animals, externally 1018, 4871

Clerodendrum glabrum E. Mey.

Deciduous tree, up to 9 m tall, in open and closed communities, forest precursor; very common; flowers December to January (to May); browsed by stock and Bushbuck; flowers visited by large black ant, honey bee (for nectar), moth (*Euchromia amoena* Moschl.) and butterfly (Pieridae); apparently distributed by birds 655

Avicennia marina (Forsk.) Vierh.

Evergreen tree, up to 11,4 m tall (stem 76 cm d.b.h.); pioneer mangrove in Sipingo estuary and adjacent intertidal parts, above high water ordinary neap tide (pneumatophores extend lower than this where drainage adequate or salinity reduced), abundant, initially dominant, particularly in more saline parts, not tolerant of deep shade. Roots mainly shallow, radiating, spread varies with environmental conditions (radius of 5,5 m measured on young plant 2,1 m tall in open pioneer community in muddy sand); erect pencil-like pneumatophores up to 950 m^{-2} produced from horizontal roots; absorbing roots produced from all subterranean parts including buried pneumatophores; descending adventitious roots (like short pneumatophores in appearance) occur on deeply shaded, generally non-vertical, old stems; with prolonged inundation supporting roots produced from lower stem, pneumatophores elongate (measured up to 690 mm above substrate) and pneumatophore-bearing roots extend into water (these generally grow into substrate on subsequent exposure); supporting or anchoring roots, when old, with little or no aerenchyma, young roots and pneumatophores with good development of aerenchyma. Chlorenchyma in cortex in all non-subterranean parts including submerged pneumatophores, generally masked by thin flaking bark, whitish brown when dry, translucent when wet. Rate of stem increment and number of annual rings bear little direct relation to age: rate of growth more rapid where drainage improved and salinity not excessive, particularly at first; stem with radii 70 mm to 108 mm showed 48 to 62 "annual" rings respectively yet maximum age was 22 years. Viviparous; seedling one (rarely two) falls entire within pericarp; mature fruit ovoid, laterally compressed, flatter on one side than other, size variable, up to 33 mm long, 26 mm broad, 16 mm deep; radicle enlarged, villous, root buds prominent, hypocotyl slightly curved 9-15 mm long, c. 3 mm diameter; plumule villous at basal nodes, epicotyl shortly elongated at time of fruit fall, 1,5-5 mm long, 1-2 mm diameter; cotyledons large, thickened, longitudinally folded, bi-lobed, lobes differ in size and density, lobes with higher density adjacent to flat side of fruit, outer cotyledon velutinous on flattened side, glabrous or sparingly velutinous at first on rounded side; due to inequality of size of cotyledon lobes plumule lies towards rounded side of fruit while radicle directed towards flattened side; propagules generally float flat side down; pericarp of mature fallen fruit soon splits when wet (rarely partially split before drop); when released hypocotyl elongates and cotyledons begin to unfold; after roots (fibrous) established, hypocotyl straightens lifting cotyledons and young stem 20-25 mm above substrate, generally little or no further elongation of hypocotyl (although measured to 50 mm long), subsequent growth of axis due to stem elongation, generally rapid at first; growing tip protected by adpressed juvenile leaves; cotyledons shed after first 1 to 3 pairs of leaves open. Flowers November to March (to May); fruit dropped (February to) March to April (to August). Elsewhere flowers visited by honey bee (Richards Bay, teste R.D. Guy) and ant; seedling within pericarp before fruit fall sometimes eaten by unidentified moth larva .. 764, 3740

LAMIACEAE (LABIATAE)

Leonotis dysophylla Benth.

Perennial robust herb, up to 2 m tall, rootstock woody, in open secondary scrub and grassland on Isipingo Flats, loamy sand; very locally frequent; flowers (late November to) December to April, visited by ant (*Plagiolepis custodiens*) after corolla, androecium and style fallen, elsewhere visited by sunbirds, carpenter bee and wasp 6828

L. leonurus (L.) R. Br. var. *leonurus*

Perennial, robust herb up to 3 m tall, main stem 5 cm diameter at 1 m above ground; in open scrub and tall grassland; frequent; flowers (March to) May to July (to September); visited elsewhere by honey bee, butterfly and sunbird 887

Leucas lavandulaefolia Sm.

Branched erect herb, up to c. 75 cm tall, in disturbed places, slightly loamy sands; frequent; flowers December to August 18

Stachys aethiopica L.

Diffuse perennial herb, straggling, in grassland and in open scrub and woodland, particularly at forest margins; common; flowers October to March, visited by bees (including honey bee) 589, 3775, 6812, 6835

Hyptis pectinata (L.) Poit.

Erect robust herb, c. 200 cm tall, in open scrub on flood-plain of upper Mbokodweni River, in sandy loam; rare; flowers May to September, elsewhere visited by wasp 5892

Endostemon obtusifolius (E. Mey. ex Benth.) N.E. Br.

Branched erect suffruticose herb, c. 90 cm tall, partially shaded in scrub and reeds on bank of Mbokodweni River, in coarse sandy alluvium; rare; flowers December to March 6836

Plectranthus ambiguus (Bolus) Codd

Perennial suffruticose herb, up to 107 cm tall, in dune forest, common; rare in low-lying woodland-forest, just above tidal river; flowers March to April 820, 4903

P. madagascariensis (Pers.) Benth.

Perennial, brittle-stemmed herb c. 50 cm tall; in short woodland-forest, mostly marginal, in low-lying area just above tidal river; locally common; flowers May to November 327, 1204

P. verticillatus (L.f.) Druce

Perennial herb, erect up to 75 cm tall, more generally straggling; in light shade or open parts in forest and woodland, well-drained soils; frequent, especially in short open woodland-scrub on steep seaward-facing hills; flowers October to April 136, 1015, 1235, 5299

Ocimum canum Sims

Erect bushy herb, c. 75 cm tall, in secondary vegetation on disturbed flood-plain of Mbokodweni River; locally common; flowers November to March, elsewhere visited by wasp 1350

O. urticifolium Roth.
Erect branched herb, up to c. 60 cm tall, in disturbed open woodland and scrub on south side of Mbokodweni Valley; locally frequent; flowers December to March.1342

SOLANACEAE

Nicandra physaloides Gaertn.
Annual herb, branched, erect up to 150 cm tall, in open disturbed places; common; flowers (August to) October to May (to July); elsewhere seeds from mature fruit eaten by Cape Canary 3746, 5004

Withania somnifera (L.) Dun.
Perennial erect branched suffrutex, up to 150 cm tall, in disturbed place, alluvial silty sand; rare; flowers August to April 6219

Physalis angulata L.
Annual herb, erect or ascending, 8-50 cm tall, in disturbed, generally low-lying, places, sandy or loamy soils; common; flowers March to September . 819, 5895, 6176

P. peruviana L.
Robust herb, stems erect, ascending or semi-scandent, up to 110 cm tall, in disturbed open places, often near refuse dumps; frequent; flowers apparently in all months, at least October, February to July; browsed by Bushbuck; fruit edible 4859

P. viscosa L.
Perennial herb, rhizome branched, extensive, aerial stems erect 10-30 cm tall, in disturbed open places, sandy soils; common; flowers August to April, visited elsewhere by honey bee (for nectar) 5264

Solanum acanthoideum E. Mey.
Low suffrutex, 60-80 cm tall; in disturbed places; frequent; flowers throughout summer; cut fruit rubbed on site of 'sandworm' infection (cutaneous *larva migrans*) considered effective cure 4897

S. aculeatissimum Jacq.
Robust herb c. 75 cm tall; in disturbed places, sandy soils; occasional; flowers summer; apparently bird-distributed 4888

S. sp. probably *S. duplo-sinuatum* Klotzsch
Perennial suffrutex up to 210 cm tall (mostly 100-150 cm); in disturbed open places; very common; flowers and fruit throughout year, flowers least June to July; cut fruit rubbed on site of 'sandworm' infection (cutaneous *larva migrans*) considered effective cure 1207, 3762

S. geniculatum E. Mey.
Scandent suffrutex, in short dense maritime scrub immediately above beach or above supralittoral rocks; locally occasional; flowers March to May, elsewhere visited by small black bee (for pollen) 4975

S. giganteum Jacq.
Soft-wooded small tree, up to 240 cm tall; in disturbed area near reed-swamp; rare; flowers October to November; elsewhere mature fruit eaten by Black-eyed Bulbul .. 608

S. mauritianum Scop.
Soft-wooded, fast-growing tree, up to 610 cm tall (stem 15 cm d.b.h.), in disturbed places, particularly in riparian scrub and woodland where very common; flowers in all months, particularly April to November, visited by honey bee (for pollen) and carpenter bee (for nectar); fruit eaten by various birds, and flies (Drosophiliidae) often on ripe fruit 404

S. nigrum L.
Apparently annual, erect, branched herb 20-70 cm tall; in disturbed open places; common; flowers (July to) August to April (to June); browsed by Bushbuck, fruit eaten by birds and man 3755

S. seaforthianum Andr.
Scandent suffrutex, up to c. 150 cm high, at disturbed margin of woodland-forest, slightly loamy red sand; occasional; flowers February to July 6534

S. sisymbrifolium Lam.
Branched robust herb up to 100 cm tall, in disturbed places; rare; flowers November to February 5291

Lycopersicum esculentum Mill.
Weak-stemmed straggling herb, up to 120 cm high where supported by other herbs; common around refuse dumps or in recently disturbed woodland or dune forest; flowers August to April, ripe fruit eaten by Speckled Mousebird and man 6210

Datura ferox L.
Branched erect robust annual herb, up to c. 90 cm tall, in disturbed open places; occasional; flowers March .. 6243

D. stramonium L.
Branched erect annual robust herb, up to c. 100 cm tall, in disturbed open places; common; flowers August to May 4904

Cestrum laevigatum Schltr.
Brittle-stemmed shrub or tree up to c. 5,5 m tall, in scrub and woodland particularly in low-lying, somewhat moist places and where disturbed; also cultivated as hedge-plant; very common; flowers January to July; fruit mature February to September (to October); distal leaves and twigs occasionally browsed by Bushbuck; flies visit outside and bases of flower buds; fruit eaten by birds, i.a. Speckled Mousebird 377

Petunia nyctaginiflora Juss. x *P. integrifolia* Schinz & Thellung
Herb, stem erect or ascending, up to c. 70 cm tall; common Garden Petunia, occurs as ruderal in open disturbed low-lying places on Isipingo Flats; locally occasional; flowers November to January 6319

SCROPHULARIACEAE

Nemesia denticulata (Benth.) Grant
Erect slender perennial herb, up to c. 35 cm tall, in grassland and open scrub, sandy soils; common; flowers in all months, particularly numerous in spring following grass-fires 299, 613

Diclis reptans Benth.
Small annual herb, stems decumbent, in grassland and in open disturbed places, particularly where low-lying or somewhat moist; common; flowers July to October .. 975

Anastrabe integerrima E. Mey. ex Benth.
Shrub up to 5,5 m tall, relict in disturbed riparian woodland, Golf Course in Mbokodweni Valley; rare; flowers (October to) November to April (to June) 3024

Manulea parviflora Benth.
Perennial herb, erect, 40-90 cm tall, in open grassland and scrub, often where disturbed; sandy soils; frequent; flowers (July to) October to March 1336, 5333

Sutera floribunda (Benth.) Kuntze
Perennial bushy suffruticose herb, erect or somewhat spreading, up to 120 cm tall, marginal to low-lying woodland; locally common; flowers (February to) March to June (to July), elsewhere visited by honey bee (for nectar) 387

S. kraussiana (Bernh.) Heirn
Perennial slender suffrutex, erect or ascending up to 120 cm tall,

generally diffuse, in riparian and other low-lying grassland and open scrub; common; flowers (July to) October to March (to April) 989, 5357

Polycarena bracteata (Benth.) Levyns
Annual, small erect or partially decumbent herb, 10-30 cm tall, in open disturbed places, in slightly clayey sands; common; flowers (July to) August to March 5813

Bacopa monnieri (L.) Wettst.
Weak-stemmed decumbent to procumbent herb, flowering branches erect, up to c. 15 cm tall, rooting from horizontal stem; in wet mud or in shallow water on central Isipingo Flats, locally common; flowers (November to) December to April, visited by honey bee for nectar 6816

Ilysanthes dubia (L.) Bernh.
Annual small herb, stem erect or decumbent, outer stems sometimes rooting below, 5-15 cm tall, in moist sand and or mud at edge of Mbokodweni River and other non-saline, moist, open places on Flats; locally common; flowers September to March; eaten by cattle; elsewhere visited by small bee 5828

Alectra sessiliflora (Vahl) Kuntze var. *sessiliflora*
Erect branched herb, up to c. 60 cm tall, in open grassland, hemiparasitic on roots of forbs, generally in low-lying parts; common; flowers September to May 4735

Rhamphicarpa tubulosa (L.f.) Benth.
Erect hemiparasitic herb, up to c. 70 cm tall, in open grassland somewhat moist areas; common; flowers June to October (to December) 892

Striga asiatica (L.) Kuntze
Erect herb, up to c. 20 cm tall, hemiparasitic on roots, amongst grasses in open woodland on slopes south of Mbokodweni Valley and in low-lying grassland and open scrub on Isipingo Flats; locally common; flowers December to April 1345, 6229

Hyobanche fulleri Phill.
Erect herb, stem stout, length variable depending upon depth to which buried, aerial part consisting essentially of inflorescence only, holoparasite on roots of *Chrysanthemoides monilifera* (L.) T. Norl in semi-open dune scrub; locally common; flowers August . 4669, 4670

SELAGINACEAE

Hebenstreitia comosa Hochst.
Perennial herb, erect up to c. 60 cm tall, in grassland, low-lying area, loamy sand; locally occasional; flowers August to December, visited by beetle 1004

Selago woodii Rolfe
Perennial suffruticose herb, stems erect or diffuse, up to c. 50 cm tall, in open scrub and grassland, not on well-drained white sands of Isipingo North; common; flowers (October to) December to March (to April), visited by wasp and fly (Calliphoridae: Rhiniinae) 970, 6296

Walafrida densiflora (Rolfe) Rolfe
Semi-prostrate herb, in disturbed open low-lying place; rare; flowers December 6295

BIGNONIACEAE

Tecomaria capensis (Thunb.) Spach
Scandent shrub in scrub and woodland; common; flowers in all months, particularly February to October, visited elsewhere by sunbirds, butterflies, flies and honey bee (for nectar and pollen); browsed by game 855

PEDALIACEAE

Ceratotheca triloba (Bernh.) Hook. f.
Annual erect branched robust herb up to 150 cm tall, in disturbed places or secondary grassland; frequent; flowers October to April (to August), visited elsewhere by carpenter bee and honey bee (for nectar) 788

ACANTHACEAE

Thunbergia alata Boj. ex Sims
Twining herb in disturbed places; rare; flowers February to November, visited by small bee 4978

T. dregeana Nees
Twining herb in scrub and woodland, including dwarf salt-spray zone, and in open places in dune forest; common; flowers October to April, visited by small bee (for pollen) 571, 962

Phaulopsis imbricata (Forsk.) Sweet
Perennial branched herb, often straggling, stems erect or decumbent, rooting at nodes, with erect branches, 8-115 cm tall, in open scrub and short low-lying woodland-forest, and in dwarf salt-spray zone; common; flowers (March to) April to July (to August) .. 906, 4912

Dyschoriste depressa Nees
Herb, erect and spreading, rooting occasionally at lower nodes, up to c. 45 cm tall, in disturbed scrub and grassland, low-lying places, particularly near rivers (above tidal influence); frequent; flowers (July to) September to February; eaten by Bushbuck 5861

Chaetacanthus setiger (Pers.) Lindl.
Herb, erect, sometimes shortly decumbent as well, 10-20 cm tall, in open grassland and open scrub, sandy soils; common; flowers (June to) August to March (to May), visited elsewhere by butterflies (Hesperidae and Pieridae) .. 552

Barleria obtusa Nees
Perennial suffruticose herb, stems erect, diffuse or somewhat scandent, up to c. 2 m high, in scrub and woodland, including dwarf salt-spray zone, and at forest margins throughout; very common; flowers March to June (to July), visited by butterflies (Pieridae) 252, 4918

Asystasia gangetica (L.) T. Anders.
Perennial evergreen herb, stems decumbent, rooting at intervals, sometimes somewhat scandent; in open communities throughout, including dwarf salt-spray zone and disturbed places; very common; flowers in all months, particularly October to May, essential organs and base corolla eaten by beetle; elsewhere flowers visited by large black ant 769

Peristrophe natalensis T. Anders.
Perennial deciduous herb, erect, scrambling or scandent to c. 3 m high, in scrub, woodland and at forest margins where not affected by direct on-shore breezes, (slightly) loamy sands; common; leaves mostly fallen when in full flower and fruit; flowers (February to) April to August (to September), visited by honey bee (for nectar), butterfly (Pieridae) and elsewhere (teste R. Sprawson) by Collared Sunbird; elsewhere eaten by game and goats 827, 4247, 4974

Dicliptera heterostegia Presl ex Nees
Perennial herb, erect or frequently outer stems decumbent, rooting at lower nodes, up to c. 70 cm tall; in woodland-forest and at forest margins, generally in light shade, also in dwarf salt-spray zone; common; flowers March to June (to July), elsewhere visited by honey bee and flies; often browsed 826, 1150, 4906, 4909

Hypoestes verticillaris (L.f.) R. Br. ex C.B. Cl.
Herb, stems ascending, up to c. 50 cm tall, in dwarf salt-spray zone towards base of seaward-facing hills; common; flowers April to July (to August), elsewhere visited by small bee (for pollen) and fly (Tabanidae) ... 1149, 4983

Rhinacanthus gracilis Klotzsch
Herb, stems slender, erect up to 120 cm tall, in light or partial shade in woodland and woodland-forest, low-lying areas; locally common; flowers (February to) March to July (to August), elsewhere browsed by antelope 322, 4908

Isoglossa ciliata (Nees) Lindau
Robust herb, well-branched, erect or scrambling, up to c. 90 m tall, in woodland-forest, generally shaded, and in dwarf salt-spray zone; common; flowers March to July, visited elsewhere by honey bee. See note under next entry 4899, 4919, 4922

I. stipitata C.B. Cl.
Branched robust herb generally spreading, up to c. 90 cm tall, in short woodland-forest (mostly marginal) in low-lying area just above tidal lagoon and river; locally common; dies after periodic flowering; flowers July to August, plants dead by November, observed only in 1963 (habitat destroyed 1965) 4663

Note: National Herbarium, Pretoria, considers this to be *I. ciliata* (Nees) Lindau, but it differs from *I. ciliata* as represented by *Ward* 4899, 4919, 4922 and other gatherings, by having almost no leaves at time of flowering and these as well as stems brownish, having a marked somewhat musty odour when crushed and having stalked glands on bracteoles, whereas *I. ciliata* has leaves green, although possibly slightly smaller, at time of flowering, no odour on crushing and although bracteoles and calyx have hairs these are not glandular.

I. woodii C.B. Cl.
Gregarious, branched suffrutex, stems mostly erect, size varies with age and degree of exposure to sun and salt-spray, measured up to 410 cm tall (in dune forest); adventitious roots produced from nodes of fallen stems and, in dense shade, from lower nodes up to 30 cm above ground, even on erect stems; in maritime scrub and woodland and in woodland-forest and forest throughout, mostly in light shade; very common, in parts abundant; generally just before or as flowers open, large leaves immediately below inflorescence turn purple distally before yellowing, wilting and dropping; flowers periodic, in any one place number of plants flowering increases each year from two years before peak, approximately 10 year intervals between peaks; flowers (March to) April to July (to November) in non-peak years, but rather March to June (to August) in peak years; whole plant eventually dies after flowering; leaves and tips of young stems eaten by Bushbuck and, apparently by Blue Duiker; flowers visited by moth (Sphyngidae), butterfly (Pieridae), honey bee (for nectar) and thrips, elsewhere by several other butterflies, other bees, wasp and flies 254, 6601

Justicia protracta (Nees) T. Anders.
Erect herb, 15-25 cm tall, in stunted vegetation at base of steep seaward-facing hills, south of Mbokodweni Lagoon; locally common; flowers September to June, elsewhere visited by honey bee 3023

Monechma debile (Forsk.) Nees
Erect branched herb, up to 60 cm tall; stem and roots strongly scented, rather vanilla-like, in open short secondary vegetation, low-lying area, sandy soil; occasional; flowers January to May 5953

PLANTAGINACEAE

Plantago major L.
Acaulescent herb, leaves basal, size varies with degree of exposure and availability of moisture, inflorescence up to 77 cm tall, where protected; in disturbed places, low-lying or somewhat moist; common; flowers throughout summer, also recorded in June 1303

RUBIACEAE

Kohautia virgata (Willd.) Brem.
Erect branched herb, up to 50 cm tall, in grassland and open scrub, sandy soils, low-lying areas; common; flowers October to May; elsewhere eaten by antelope 1008

Oldenlandia affinis (Roem. & Schult.) DC.
Herb, slender, diffuse or procumbent, in open scrub where grasses short, sandy soils; locally common in Mbokodweni Valley; flowers possibly throughout year, recorded November to August 5553

O. cephalotes (Hochst.) Kuntze
Herb, slender, erect or decumbent; in low-lying somewhat moist places; locally frequent; flowers September to June . 391

O. herbacea (L.) Roxb.
Slender, much branched herb, 10-25 cm tall, in open estuarine scrub just above extreme tidal level; frequent; flowers May to June 879

Pentodon pentander (Schumach.) Vatke
Herb, somewhat fleshy, decumbent, rooting at lower nodes, in moist places; common, particularly where disturbed; flowers September to June 262

Burchellia bubalina (L.f.) Sims
Small tree, up to 4 m tall, in woodland just above tidal lagoon and river; locally common; flowers September to December; elsewhere fruit eaten by birds i.a. Sombre Bulbul (teste T.B. Oatley) 907, 984

Xeromphis obovata (Hochst.) Keay
Shrub up to c. 5 m tall; in scrub and woodland, throughout, particularly on inland-facing slopes of main hills and in lower-lying areas away from direct on-shore winds; common; old leaves dropped immediately prior to production of new leaves and flowers, mid-September to end-October; elsewhere browsed by Bushbuck; flowers visited by moth 539, 981

X. rudis (E. Mey. ex Harv.) Codd
Briefly-deciduous shrub, up to 2,7 m tall, in woodland and woodland-forest on inland-facing slopes of main hills and in lower-lying areas away from direct maritime influence; new leaves produced, depending on winter rains, July to September; flowers September to March; elsewhere browsed by stock and game, flowers visited by bees (for pollen and nectar) 964

Mitriostigma axillare Hochst.
Shrub, 50-100 cm tall, in woodland and open or lightly shaded parts in dune forest; frequent; flowers (July to) August (to September) 921, 1195, 5295, 5811

Gardenia thunbergii L.f.
Tree, up to 3,7 m tall, in dune forest and in woodland-forest on main Isipingo Beach hill; rare; flowers December to February 5098

Rothmannia globosa (Hochst.) Keay
Tree, up to 4,6 m tall, in woodland and woodland-forest on main hills, reddish sandy soil; common; flowers June to August (to September), elsewhere visited by carpenter bee 889

Tricalysia sonderana Hiern
Evergreen shrub, up to 3 m tall, in scrub, woodland and woodland-forest in sandy soils throughout; especially in maritime communities; very common; flowers September to November, (March, following break in severe summer drought); elsewhere browsed by Bushbuck 530, 766

Kraussia floribunda Harv.
Evergreen slender shrub, up to 3,7 m tall, in scrub, woodland and woodland-forest throughout, particularly in low-lying areas; common; flowers November to December; fruit ripe April (to August), edible and apparently eaten by birds 645, 1206

Vangueria chartacea Robyns
Very briefly deciduous shrub or small tree, up to 3,7 m tall, in woodland-forest and forest throughout; common; new

leaves produced October; flowers November to December (to February) 572, 1233, 1288, 4881, 4875

V. infausta Burch.

Deciduous robust shrub up to 2 m tall, in open scrub and open woodland, away from direct maritime influence, sandy soils; frequent; new leaves produced with flower buds; flowers October to November; fruit mature February to March, edible; elsewhere browsed by game, flowers visited by wasps and birds - Cape White-eye, Black-eyed Bulbul, Sombre Bulbul, Collared Sunbird; general use by Zulu: distal twigs with small branches at right angles used for stirring porridge, also smeared with animal fat as protective charm placed in roof of hut as protection against lightning (*abafana bezulu*) 1011

Lagynias lasiantha (Sond.) Bullock

Briefly-deciduous shrub, generally somewhat scandent, up to 4,5 m tall, in closed woodland and woodland-forest, mainly on xerocline of main hills, reddish sandy soils; common; old leaves dropped just before new leaves produced in October; flowers December to January, fruit mature May to October, edible and eaten by birds 241, 1261, 4866, 4970

Canthium inerme (L.f.) Kuntze

Tree up to 9 m tall (stem 36 cm d.b.h.), generally several-stemmed; in wooded communities, including dwarf salt-spray zone, but not where canopy very dense (unless as relict); common all over; forest precursor; semi-deciduous or very briefly deciduous, new leaves produced while some old still present or shortly after drop (late July to) September to early October; flowers (late July to) mid-September to October; fruit mature (December to) January to March; elsewhere browsed by cattle and game; flowers visited by bees (for nectar), large black ant, and elsewhere by beetle and various flies; fruit eaten by man and various birds including Black-eyed Bulbul 540, 560, 960

C. locuples (K. Schum.) Codd

Small tree up to c. 4,6 m tall; marginal to and within upper part of short woodland-forest on steep inland-facing slope of main Isipingo Beach hill, reddish sandy soil; locally common; flowers not recorded locally 3758

C. obovatum Klotzsch

Evergreen tree, up to 12 m tall, in scrub, woodland and forest all over; very common; flowers December to February; fruit mature April to May; coppice browsed by Bushbuck elsewhere; flowers visited by honey bee (for nectar) and moth (*Euchromia amoena* Moschl.); fruit eaten by Natal Robin (teste T.B. Oatley, elsewhere) and Indian Myna 904

C. spinosum (Klotzsch) Kuntze

Deciduous shrub, up to 3 m tall, in scrub and woodland away from direct maritime influence; new leaves produced September to October; flowers May to December (to January); elsewhere fruit eaten by Black-eyed Bulbul . 903

Pavetta alexandrae Brem.

Shrub, up to 3 m tall, in scrub and woodland where not influenced directly by on-shore winds, loamy alluvial sand or reddish sandy soils; common; flowers December 6208

P. revoluta Hochst.

Shrub, up to c. 4 m tall, in woodland and forest, extending into dwarf salt-spray zone, (where may be only c. 15 cm tall), sandy soils; common; flowers (December to) January to February (to March); seeds apparently bird-distributed 657, 872, 4857

Psychotria capensis (Eckl.) Vatke

Evergreen shrub, up to 4 m tall, mostly c. 2 m, in woodland and forest throughout, generally in shade; common; flowers (September to) October to January (to March), visited elsewhere by flies, butterflies and honey bee (for nectar); fruit apparently eaten by birds 870, 1244

Galopina aspera (Eckl. & Zeyh.) Sond.

Perennial herb, stems slender erect or somewhat diffuse, up to c. 50 cm tall, in tall grassland and open scrub marginal to woodland-forest, low-lying areas; occasional; flowers January to February 1378

Anthospermum littoreum L. Bol.

Evergreen suffrutex, stems erect or somewhat straggling, up to c. 90 cm tall, in open parts in maritime woodland and scrub including dwarf salt-spray zone at base of seaward-facing hills and in open estuarine vegetation just above tidal limit, sandy soils; common; flowers November to February 280

Richardia brasiliensis (Moq.) Gomez

Perennial procumbent herb, tap root well developed, in disturbed places; common; flowers (July to) August to May, visited by ants generally after corolla freshly fallen, wasp and, elsewhere, by butterfly (Pieridae) 976

Hydrophylax carnosa Sond.

Perennial succulent herb, creeping stem long, subterranean or sometimes above sand level, upright branches mostly very short but length varies with depth of burial by wind-blown sand, leafy apices generally forming low mats; pioneer in wind-blown sand where subject to direct salt-spray; common; early dune builder, not shade tolerant; flowers August to May (to June); White-fronted Sand-plover often nests on low dunes formed by *H. carnosa* 569

Diodia natalensis (Hochst.) Garcia [=*Borreria natalensis* (Hochst.) K. Schum. ex S. Moore]

Erect slender herb, up to c. 60 cm tall, in low-lying grassland, clayey loam; locally frequent; flowers November to March 6809

Borreria scabra (Schumach. & Thonn.) K. Schum.

Annual herb, much branched, erect up to 50 cm tall, in disturbed upper flood-plain of Mbokodweni River, sandy soil; locally frequent; flowers February to April 6050

Rubia cordifoli L.

Herbaceous climber, in scrub and woodland and at forest margins throughout; common; flowers March to May (to June); elsewhere young browsed by game, fruit eaten by various birds 251

DIPSACACEAE

Scabiosa columbaria L.

Perennial herb, rootstock woody, stem up to c. 80 cm tall, in open grassland and open scrub, particularly in low-lying areas; common; flowers (August to) September to October (to April); visited by honey bee (for nectar and pollen) and several other bees (for nectar), butterflies (*Danaus chrysippus*, Lycaenidae and Pieridae) and elsewhere by beetle and wasp 553

CUCURBITACEAE

Mukia maderaspatana (L.) M.J. Roem. [=*Melothria maderaspatana* (L.) Cogn.]

Climbing herb, generally only up to 1,5 m high, in low-lying often disturbed areas; locally frequent; flowers November to June 1302

Zehneria parvifolia (Cogn.) J.H. Ross [=*Melothria parvifolia* Cogn.]

Climbing herb, stems slender, much branched, up to 2-2,5 m high, marginal to dune forest and in disturbed woodland in well-drained soils, common; flowers December to May (to July) 832

Momordica involucrata E. Mey. ex Sond.

Herbaceous climber, stems rather slender, much branched, several metres long, in scrub, woodland and at forest margins, often on seaward-facing slopes and where disturbed; common; flowers September to May (to July) 729, 730

Citrullus lanatus (Thunb.) Matsumura & Nakai
Herb, stems procumbent, generally long-trailing, in open disturbed places on Flats, locally common; also occasional on banks of Mbokodweni Lagoon after floods; flowers December to April, visited by honey bee ... 6242

Cucumis anguria L. var. *longipes* (Hook. f.) A. Meeuse
Herb, stems trailing, in open short grassland, sandy soils; occasional; flowers October to January 1014

Lagenaria mascarena Naud.
Stems herbaceous, robust, long trailing or climbing, in riparian woodland, scrub and grassland; common; rare in stunted scrub just above beach south of Mbokodweni River; flowers August to June; ants, including *Cremastogaster* sp., and, elsewhere, fly visit extra-floral nectaries on leaves and on calyx of buds and open flowers; flowers visited by carpenter bee and smaller bee and elsewhere by other bees and fly 842

Coccinia palmata (Sond.) Cogn.
Herbaceous climber, stems branched, several metres long, in woodland or marginal to forest, often where disturbed; common; flowers December to June 289

C. rehmannii Cogn. var. *littoralis* A. Meeuse
Herbaceous climber in secondary scrub; sandy soils on Flats; locally frequent; flowers seen only February to March; fruit mature March 6863

CAMPANULACEAE

Wahlenbergia undulata A. DC.
Perennial herb, stem erect, up to c. 75 cm tall, in open grassland and open scrub all over; common; flowers in all months, especially September to April 969, 1006

Lightfootia denticulata (Burch.) Sond.
Perennial herb, stems several erect up to c. 25 cm tall, in grassland and open scrub, sandy soils, Isipingo Flats and Mbokodweni Valley; common; flowers December to May 1329

LOBELIACEAE

Cyphia corylifolia Harv.
Perennial herb, stem shortly twining, amongst tall grasses marginal to woodland-forest, low-lying area; rare; flowers February 1377

Lobelia anceps L.f.
Perennial herb, stem decumbent, rooting at nodes, in moist, somewhat brack places; common; flowers throughout year, less prolific in winter 392, 520, 902

L. coronopifolia L.
Perennial suffruticose herb, rootstock woody, stem branched, more or less erect, up to c. 60 cm tall in open scrub and grassland in Mbokodweni Valley, sandy soils; frequent; flowers in all months, elsewhere visited by honey bee (for nectar) and butterfly (*Danaus chrysippus*) ... 1337, 4836

L. erinus L.
Annual herb, stem slender, erect or straggling; in open, low-lying generally moist places, clayey soils; locally common; flowers August to June, elsewhere visited by butterfly 6599, 6797

Monopsis stellarioides (Presl) Urb.
Decumbent herb, in open short hygrophilous grassland; locally common; flowers February 5353

GOODENIACEAE

Scaevola thunbergii Eckl. & Zeyh.
Succulent shrub, stems erect or more generally decumbent, ascending distally, up to c. 100 cm tall, spreading, especially when buried; slender fibrous roots freely produced from buried stems; leaves crowded distally, more or less upright, especially when very young, protecting apical bud; in open sand above high water level, adjacent to estuary and, more particularly, along sea-shore; very common; important strand pioneer and dune-builder; not shade tolerant nor tolerant of direct wave splash, also stems die back distally, usually to point of burial, when undercutting of dune by wave action causes originally upright stems to collapse (this is probably due to the change in posture allowing the direct access of salt-spray on to previously protected apical buds); flowers September to January (to February), visited by small bee (for nectar) and elsewhere by honey bee (for nectar) and carpenter bee: fruit mature February to June (to July), dispersed by gravity and wind along beach as well as by water currents 568

ASTERACEAE (COMPOSITAE)

Ethulia conyzoides L.
Erect, sparingly branched herb, up to 120 cm tall, in moist places, fresh or slightly saline; common; flowers (August to) September to April (to July), visited by wasp and elsewhere by bees 269

Vernonia adoensis Sch. Bip. ex Walp.
Erect suffrutex, up to 2,3 m tall, in open scrub and partially disturbed woodland on Flats and hill south of Mbokodweni River; locally frequent; flowers mid-April to early June 10, 6274

V. angulifolia DC.
Climbing much-branched suffrutex, sometimes trailing, in all wooded communities (including salt-spray zone) and extending into grassland where not burnt; very common; flowers (May to) June to July (to August) (October), visited by butterflies (Pieridae, *Precis clelia, Danaus chrysippus* and others), moths, various flies, honey bee and other bees (for nectar), wasp and beetle 17

Ageratum houstonianum Mill.
Erect branched herb, up to 100 cm tall, in disturbed places, particularly low-lying or somewhat moist; common; flowers in all months, especially April to December, visited elsewhere by small bee 403

Eupatorium odoratum L.
Suffrutex, diffuse, somewhat erect, up to c. 3 m, often scandent, may take root where stems fallen; grassland invader and in scrub marginal to closed wooded communities, particularly in disturbed places, common; stems die back distally to below infructescences in August to September after fruiting, soon followed by production of new shoots late August to September; flowers (April to) June to July (to August), in some situations apparently when under drought conditions some may not flower although few of these may flower later in November to December; flowers visited by various butterflies, (Pieridae, *Precis clelia* and *Danaus chrysippus*), moth (*Amata* sp.), honey bee (for nectar) and flies, including drone fly (Syrphidae) 894, 4664

Mikania cordata (Burm. f.) B.L. Robinson [=*M. natalensis* DC.]
Herbaceous climber in low-lying, often moist, situations, generally in open communities or marginal to woodland-forest; common; flowers July to September, elsewhere visited by butterfly (*Salamis parhassus*), honey bee, various wasps and flies 476

Aster squamatus (Spreng.) Hieron.
Annual herb, erect, flowering specimens 8 cm to c. 200 cm tall; in moist, often disturbed, places, fresh or slightly saline;

very common; flowers (November to) February to September, visited elsewhere by bee (for nectar) 308

Felicia erigeroides DC. [=*Aster erigeroides* (DC.) Harv.]
Erect suffruticose herb, up to 100 cm tall, in grassland, well-drained sandy soils; very common; flowers March to August 15

Microglossa mespilifolia (Less.) B.L. Robinson
Scandent suffrutex, well-branched, in open scrub and woodland and at forest margins; frequent; flowers in all months 328, 557, 4665

Nidorella auriculata DC.
Robust herb up to 160 cm tall, in tall grassland and open scrub, generally where disturbed; frequent; flowers (November to) December to June, visited elsewhere by small bee 5290, 5351

N. linifolia DC.
Herb up to c. 90 cm tall; in brack muddy soils, just above high water ordinary spring tide, often in or slightly higher than *Juncus kraussii* zone; common; flowers July to May visited by wasp 275

Conyza bonariensis (L.) Cronquist [=*Erigeron bonariensis* L.]
Robust branched annual herb, erect, up to 120 cm tall; in disturbed open places; very common ruderal; flowers (August to) September to April (to July), visited by small bee and fly (Syrphidae) 877, 5942

C. canadensis (L.) Cronquist [=*Erigeron canadensis* L.]
Erect annual herb, up to 195 cm tall (generally only 40-120 cm tall), branches few, slender; in disturbed open places; common ruderal; flowers (July to) October to April (to June) 312, 5303, 5943

C. chilensis Spreng.
Annual herb, up to c. 50 cm tall; in low-lying grassland and open scrub, often where disturbed, sandy loam; locally frequent; flowers September to April 5886

C. floribunda H.B. & K. [=*Erigeron floribundus* (H.B.K.) Sch. Bip.]
Annual robust erect herb, sub-woody at base, up to 230 cm tall, sparingly branched; in disturbed places; very common; flowers (August to) September to April (to June); browsed by Bushbuck; flowers visited by large black ant, wasp and honey bee (for nectar) and, elsewhere, by other bees (for pollen) 5881, 5941

C. pinnata (L.f.) Kuntze
Herb, erect, branched from extreme base, up to c. 40 cm tall; in open parts in low-lying grassland, sandy loam; locally frequent; flowers September 5894

C. scabrida DC. [=*C. ivifolia* (L.) Less.]
Slender, branched suffrutex up to 200 cm tall; in low-lying grassland, generally riparian or somewhat moist; common; flowers January to July, visited by butterfly (Lycaenidae), ant, bees and elsewhere by wasps, flies, beetle and small moth 901

C. ulmifolia (Burm. f.) Kuntze
Straggling herb; in moist places; common; flowers October to July, elsewhere visited by fly 895, 4977

Brachylaena discolor DC.
Shrub, often scrambling, or tree, largest measured 11,7 m tall with three stems from base, 30 cm, 20 cm and 33 cm d.b.h., or with single stem 11,3 m tall x 48 cm d.b.h. (these from where unburnt and not subject to direct salt-spray); heliophyte, important early invader of grassland and member of maritime scrub and woodland, very common throughout in sandy soils where not excessively moist; flowers (late June to) July to August (to early September); one of hosts of *Loranthus dregei*; elsewhere coppice eaten by Bushbuck; flowers visited by honey bee and elsewhere by another bee and several flies; useful as hedge, especially on seaward slopes, and for stabilizing wind-blown sand, stems used in construction of crude furniture, elsewhere leaves used medicinally 22, 5810

Blumea gariepina DC.
Annual herb, erect, up to 55 cm tall; ruderal in dredged sandy soil; occasional; flowers September to October 7229

B. mollis (D. Don) Merrill
Annual herb, erect, up to c. 75 cm tall, in moist, often disturbed places; frequent; flowers October to April (to June), visited by honey bee (for nectar) 4964

Laggera alata (D. Don) Oliver [=*Blumea alata* (D. Don) DC.]
Annual herb, erect, up to 120 cm tall, in riparian grassland; occasional; flowers July 896

Pluchea dioscoridis (L.) DC.
Suffrutex or slender shrub, up to c. 2 m tall, in open riparian scrub and grassland; frequent; flowers November to April; browsed by Bushbuck elsewhere (teste T.B. Oatley) 847

Facelis retusa (Lam.) Sch. Bip.
Annual herb, semi-prostrate, sometimes in many-stemmed cushion form; occasional, in open disturbed places, including river banks, more frequent on Golf Course fairways; flowers September to March 6288

Gnaphalium declinatum L.f.
Low herb, stems decumbent and erect, in moist sandy alluvium on bank of Mbokodweni River; locally frequent; flowers September to April 6285

G. luteo-album L.
Annual branched herb, stem erect and lower branches spreading - ascending up to 55 cm tall; in disturbed open generally somewhat moist places; common; flowers (July to) August to April (to June) 519, 6286

G. oligandrum (DC.) Hilliard & Burtt
Erect herb, up to 130 cm tall; on sandy river banks and in low-lying grassland, particularly where disturbed; common; flowers September to March 6315

G. pensylvanicum Willd.
Annual branched herb, stem erect and lower branches ascending, up to 65 cm tall; in disturbed, generally somewhat moist places; common; flowers (July to) August to March (to June) 521, 6287

Helichrysum argyrosphaerum DC.
Prostrate herb in disturbed sand, low-lying areas; rare; flowers August 916

H. asperum (Thunb.) Hilliard & Burtt [=*H. ericifolium* Less.]
Much branched low herb up to c. 25 cm tall, generally cushion-like especially where subject to strong on-shore breezes, in open sandy places throughout; frequent; flowers December to February 1274, 1334

H. cymosum (L.) D. Don
Much branched spreading suffrutex in grassland, scrub and open woodland, extending into upper part of dwarf salt-spray zone on seaward side of main hills, not in well-drained white sands of Isipingo North; common; flowers December to early February, visited by honey bee (for nectar and apparently pollen) 5288

H. decorum DC.
Two taxa are possibly included here; both represented by herbs whose flowers are visited by small bee (for pollen and nectar), beetles and thrips, but differing somewhat in form, flowering time and local distribution.
(i) Somewhat more slender form, annual, with main stem 25-45 (-60) cm tall, well branched from extreme base with branches ascending frequently to same height as main stem, all bearing inflorescences; flowers October to January; on seaward slopes of main hills, generally where disturbed, common 1019, 6824

(ii) Erect, rather more robust herb, up to 100 cm tall, branches absent or only occasional from base, if present, erect or not as distantly ascending as above; flowers (December to) January to May (to July), in grassland, scrub and open woodland throughout, not on higher well-drained white sands of Isipingo North 14, 4873

H. kraussii Sch. Bip.
Bushy suffrutex, up to c. 75 cm tall, in grassland and open scrub, sandy soil, often where formerly disturbed; common; flowers (June to) July to September (to October), (December), visited elsewhere by honey bee 843

H. longifolium DC.
Several-stemmed herb, up to 40-50 cm tall, in low-lying grassland, sandy soil; locally common; flowers (September to) December to February 6053

H. nudifolium (L.) Less. var. *nudifolium*
Erect, unbranched robust herb, up to 100 cm tall, in open grassland on Isipingo Flats; rare; flowers December to January (to February) 6698

H. panduratum O. Hoffm. [=*H. auriculatum* Less. var. *panduratum* Harv.]
Suffruticose herb stems spreading, flowering stems erect up to c. 90 cm tall, in mixed grassland and open scrub, loamy sands mainly on Isipingo Flats; common; flowers late November to December (to January) 5335, 6808

H. ruderale Hilliard & Burtt
Erect herb up to c. 100 cm tall in open secondary grassland on Isipingo Flats; frequent; flowers December to January 1322

H. teretifolium (L.) D. Don
Straggling low ericoid suffrutex, in estuarine scrub just above upper tidal limit, and in short vegetation on seaward slopes extending into dwarf salt-spray zone on and above supralittoral rocks; common, particularly in salt-spray zone; flowers late June to October 912

Acanthospermum glabratum (DC.) Wild
Prostrate herb in disturbed open places; common; flowers September to May 574

A. hispidum DC.
Erect branched herb 40-90 cm tall, in disturbed places; common; flowers December to May 287, 778

Ambrosia artemisiifolia L.
Robust branched herb, annual or short-lived perennial, up to 150 cm tall, slightly aromatic; in disturbed sandy soils; very common ruderal, also frequent early invader of halophilous grasses above ordinary tidal limit in estuarine areas; flowers October to April; plants eaten by domestic stock 3769, 6826, 6853, 6854

A. psilostachya DC.
Erect branched perennial herb, up to 200 cm tall, with extensive rhizomes, strongly aromatic; common ruderal in sandy soils on Isipingo Flats; flowers December to April . 6847

Xanthium spinosum L.
Annual, branched robust herb, erect up to c. 120 cm tall, in disturbed places; common (but less so than *X. strumarium*), flowers December to March (to June) . 1373

X. strumarium L.
Annual, branched robust herb, erect up to 150 cm tall, in disturbed places; common; flowers December to April; browsed by stock 754

Sigesbeckia orientalis L.
Annual branched erect herb, up to c. 80 cm tall, generally shorter, in disturbed places, sandy soil, slightly clayey or somewhat moist; common; flowers (August to) September to July, visited by small fly 5249

Eclipta prostrata (L.) L. [=*E. alba* (L.) Hassk.]
Annual, branched erect herb, up to c. 70 cm tall, in moist places, fresh or slightly saline; common; flowers (July to) September to April (to May), visited by small bee and thrips 268

Montanoa hibiscifolia Benth.
Brittle-stemmed sparingly-branched shrub, up to c. 2 m tall, garden discard, nowhere spreading, ousted by indigenous vegetation where not disturbed; occasional; flowers late May to June (to July) 5560

Tithonia diversifolia (Hemsl.) A. Gray
Perennial robust herb, erect up to 3,3 m tall, in secondary scrub, low-lying areas; occasional; flowers May to June (to July) 4982

Helianthus argophyllus Torr. & Gray
Annual robust herb, erect, up to c. 2 m tall (where not exposed to strong winds), in disturbed places, particularly on southern seaward side of main Isipingo Beach hill; common, in parts abundant; flowers late September to March (to May), elsewhere visited by honey bee (for nectar and pollen) and fly; ripe fruit eaten by Red Bishop Bird 5252

Melanthera scandens (Schumach. & Thonn.) Roberty subsp. *dregei* (DC.) Wild
Scrambling herb, in moist places; common; flowers October to April, visited by small bee for pollen and elsewhere by butterfly (Acraeidae) 1210

Spilanthes mauritiana (Pers.) DC.
Decumbent herb, rooting occasionally below, on banks of streams and drains, or in other open disturbed low-lying places; common; flowers (July to) August to May 385, 4660, 6289

Coreopsis lanceolata L.
Perennial herb, erect up to c. 60 cm tall in open short grassland, locally spread from former garden; locally common; flowers November to December (to February), elsewhere visited by butterfly (*Pyrameis cardui* Linnaeus), moth (apparently *Amata simplex* Wlk.), small bee (for nectar), honey bee (for pollen and nectar) and drone fly (Syrphidae) 6305

Bidens bipinnata L.
Annual robust herb, branched, erect up to 150 cm tall, in disturbed places, often marginal to woodland-forest; frequent; flowers December to April ... 139, 6227, 6250

B. biternata (Lour.) Merr. & Sherff
Annual robust herb branched, erect up to 150 cm tall; in disturbed open places; common; flowers (July to) September to May 6234, 6252

B. pilosa L.
Annual erect herb, size variable, flowering specimens 10-100 (-140) cm tall; in disturbed places all over, including brack soils; very common; flowers in all months; eaten by Bushbuck and goat; flowers visited by butterflies (Acraeidae and *Danaus chrysippus*) and elsewhere by bee; elsewhere fruit eaten by Yellow-eyed Canary and leaves used medicinally or cooked as vegetable . 1374, 6232, 6251

Tridax procumbens L.
Decumbent shortly-creeping herb, in open grassland, well-drained sandy soils; common; flowers in all months, least in winter, visited by butterfly (*Danaus chrysippus* Linnaeus) 1001

Galinsoga parviflora Cav.
Annual herb, slender, erect, branched, 15-82 cm tall, in disturbed places, open or lightly shaded, often somewhat moist; common; flowers in all months 881

Flaveria bidentis (L.) Kuntze
Annual herb, erect, size varies considerably, even in one stand flowering specimens from 14 cm to 170 cm tall; in

disturbed places; locally common; flowers August to June, mostly late February to mid-May; leaves and young stems eaten by stock, flowers visited by wasp (elsewhere) 5812, 6245

Schkuhria pinnata (Lam.) Cabrera
Annual herb, erect, 15-56 cm tall, in open secondary grassland on Isipingo Flats and in recently deposited silt on Mbokodweni River bank; locally frequent; flowers September to April 6206, 6241

Gaillardia pulchella Foug.
Annual, or possibly short-lived perennial, branched herb, stems erect or ascending, up to c. 60 cm tall, in short grassland and disturbed places generally close to former dwelling sites, well-drained sandy soils; locally frequent; flowers July to March 3777

Tagetes minuta L.
Erect annual herb up to 365 cm tall; in disturbed places; very common; flowers September to November, March to May (to July); eaten by stock 790

Matricaria nigellifolia DC. var. *nigellifolia*
Decumbent herb, on stream banks and other moist places, often extending into open shallow water; common; flowers September to February, elsewhere visited by fly 990

Cotula australis (Spreng.) Hook. f.
Small annual herb, stems erect or decumbent, 7-12 cm tall, in disturbed low-lying or somewhat moist places, clayey sand; locally frequent; flowers June to September (to January) 5868

Artemisia afra Jacq. ex Willd.
Suffrutex, erect, up to 150 cm tall, in open scrub in former Mlazi River valley, sandy soils; locally common; flowers March to May 294

Crassocephalum crepidioides (Benth.) S. Moore
Annual erect herb, up to c. 80 cm tall, in low-lying grassland and disturbed wooded communities; occasional; flowers late September to April 4734

Senecio brachypodus DC.
Fleshy climbing suffrutex, in woodland and open parts of forest where salt-spray not excessive; common; leaves wither during and after flowering; flowers May to July (to September), (November) 341, 900

S. chrysocoma Meerb. [=*S. paniculatus* Berg. var. *reclinatus* (L.) Harv.]
Erect branched robust herb 60-120 cm tall in short grassland, open scrub and woodland and in disturbed places, particularly where formerly wooded; very common; flowers (July to) late August to early October (to November), visited by various bees, wasp, moth, thrips, flies and elsewhere by small beetle 509, 3744

S. deltoideus Less.
Climber, stems herbaceous, well-branched, in open scrub, woodland and forest on Flats and Isipingo North; very common; flowers (April to) May to July (to August), visited by flies and elsewhere by small moths, bees and wasp 909

S. helminthoides (Sch. Bip.) Hilliard
Herbaceous climber in woodland and forest on Flats and Isipingo North; common; flowers May to June 106

S. macroglossoides Hilliard
Perennial herbaceous climber in woodland-forest, low-lying areas; occasional; flowers May to August (to February) 407

S. madagascariensis Poir.
Annual erect branched herb, 15-50 cm tall, in disturbed places or open communities; very common; flowers throughout year, visited by fly, bees, wasp and elsewhere by small moths, beetle and thrips 524

S. polyanthemoides Sch. Bip.
Erect, branched, robust herb up to 180 cm tall, in riparian scrub and in disturbed open places, generally low-lying; common; flowers (July to) August to May, visited by several flies, bees, wasps and elsewhere by butterfly (*Precis* sp.) and small beetles 512

S. tamoides DC.
Perennial herbaceous climber in woodland-forest and forest all over except where salt-spray excessive; common; flowers (late April to) May to July, visited elsewhere by butterfly (Pieridae) 366

S. variabilis Sch. Bip.
Small perennial herb in grassland and open scrub, sandy soils; locally common; flowers September to November .. 5236

Othonna carnosa Less. var. *discoidea* Oliv.
Perennial succulent herb, stem erect, branches shortly decument, 8-25 cm tall, peduncle terminal, erect up to 50 cm long (total height c. 60 cm); in open sandy places (not early beach dunes); common; flowers March to October, visited by flies and various bees (for pollen or nectar); immature fruit eaten by Yellow-eyed Canary 16

Osteospermum fruticosum (L.) T. Norl.
Perennial, decumbent straggling herb, in dwarf salt-spray zone on and just above supralittoral rocks; very common; flowers in all months visited by thrips and small black bee (for nectar) 132

Chrysanthemoides monilifera (L.) T. Norl. subsp. *rotundata* (DC.) T. Norl.
Brittle-stemmed diffuse shrub mostly 100-250 cm tall, but may be scandent up to 460 cm high; in all open or short communities and at forest margins, especially where disturbed or burnt, generally in well-drained soils not tolerant of permanent high water table; forest precursor, invader of grassland and *Scaevola thunbergii* zone on beach dunes but not tolerant of excessive salt-spray; very common; flowers (February to) March to May (to July) (to December); host of *Hyobanche fulleri*; leaves eaten by Blue Duiker and possibly Bushbuck; flowers visited by bees, including honey bee (for pollen and nectar), butterflies (Pieridae and Lycaenidae), ant, small beetle and elsewhere by wasp, pollen-eating fly (Syrphidae) and nectar-drinking fly; fruit eaten by several birds, Vervet Monkey and man 281, 874

Arctotheca populifolia (Berg.) T. Norl. [=*A. nivea* (L.f.) Lewin]
Fleshy suffrutescent herb, erect, branched, c. 30 cm tall, temporarily established after floods in February 1967, at high water level in sand with little silt on lagoon side of bar separating Mbokodweni Lagoon from sea, flowered March 1967, no sign of any specimen by early May (elsewhere on Natal coast flowers recorded August to April). Only other confirmed record of local occurrence is J.M. Wood No. 1027 from "Isipingo" August 1880, in Natal Herbarium 6168

Gazania rigens (L.) Gaertn. var. *uniflora* (L.f.) Roessler
Perennial herb, stems decumbent, rooting at nodes, especially when buried by wind-blown sand, in open sandy places where subject to salt-spray;. important in early stages of supralittoral lithosere and psammosere; abundant; flowers in all months, visited by small beetles and bees 131

Berkheya bipinnatifida (Harv.) Roessler subsp. *bipinnatifida*
Perennial erect branched robust herb or suffrutex, up to 414 cm tall, in open scrub and woodland or marginal to woodland-forest, in lower-lying areas throughout; very common, often where disturbed; flowers (January to) February to April (to May) (to July) 824

B. discolor (DC.) O. Hoffm. & Muschler
Erect branched herb, up to c. 150 cm tall, in disturbed parts in dune forest and in low-lying grassland; frequent; flowers January to May (to July) 373

B. maritima Wood & Evans

Erect branched herb, up to 150 cm tall, in woodland-forest in low-lying area just above tidal lagoon and especially in maritime closed scrub and woodland; very common; flowers January to June (to September) 402

Cirsium vulgare (Savi) Airy Shaw

Erect branched robust herb, apparently annual or possibly biennial, up to 210 cm tall, in open grassland and in disturbed areas on Isipingo Flats; common; flowers July to April 4869

Gerbera piloselloides (L.)Cass.

Perennial acaulescent herb, in open grassland sandy soils; common; flowers soon after grass burnt, followed shortly by maturation of fruit; flowers (May to) June to October 622

Hypochoeris glabra L.

Perennial acaulescent herb; ruderal at edge of canefields low-lying sandy soils; locally common; flowers August to February 5814

Taraxacum officinale Weber

Perennial acaulescent herb, in short grassland, disturbed places; common; flowers throughout year, especially in summer 1293

Launaea sarmentosa (Willd.) Kuntze [=*L. bellidifolia* Cass.]

Perennial stoloniferous herb, rooting and leaves in rosettes at nodes, in open sandy places exposed to salt-spray, important in early stages of supralittoral lithosere and psammosere; very common; flowers in all months, visited by small bees and beetle 126

Sonchus asper (L.) Hill

Erect, sparingly branched herb, possibly annual or short-lived perennial, up to c. 40 cm tall; in disturbed open places on Isipingo Flats; common; flowers September to March 5882

S. dregeanus DC. [=*S. ecklonianus* DC.]

Perennial herb, stems few or one branching from extreme base, up to 50 cm tall, leaves mostly basal, few cauline; in open short secondary grassland and open scrub on Isipingo Flats; straggling, weak-stemmed in dwarf salt-spray zone at base of seaward-facing steep slopes; common; flowers September to May 4973, 6307, 6308, 6311, 6825

S. integrifolius Harv. var. *integrifolius*

Perennial herb, stems solitary or occasionally few, sparingly or not branched, up to 50 cm tall, in open grassland, sandy soils; common; flowers (August to) September to March; elsewhere cooked as vegetable 1335, 3778, 6310

S. oleraceus L.

Annual erect herb, branched, often sparingly so, up to 195 cm tall, in disturbed places throughout including dwarf salt-spray zone (where somewhat protected) and in accumulating sandy soil in crevices in supralittoral rocks; common; flowers in any month, if sufficient moisture; eaten by Bushbuck; capitula sometimes infested by unidentified insect larva; elsewhere flowers visited by butterflies (Pieridae and Acraeidae); elsewhere cooked as vegetable 3767, 3770, 4985, 6317, 6823

S. wilmsii R.E. Fries

Perennial erect sparingly-branched herb, up to 60 cm tall, in short secondary grassland on Isipingo Flats, loamy sand; common; flowers September to March 6306

Lactuca indica L.

Apparently annual erect herb, unbranched below, flowering specimens 40-255 cm tall in disturbed open places, generally sandy soils; common; flowers (January to) February to May (to August), visited by bees including honey bee (for pollen and nectar) 337, 4890, 5302

L. serriola L.

Erect annual herb, up to 200 cm tall in disturbed open situation, sandy soil at roadside on Isipingo Flats, locally frequent; flowers November to December (to January) 6814

Summary

With a mean annual rainfall slightly in excess of 1 000 mm of which approximately 67,6% occurs in summer (October to March), supplemented by frequent heavy dew particularly in winter, mild temperatures (20,2 °C mean, without excessive variation) and relatively high atmospheric moisture conditions, mesophytic Coast Forest is the inferred climatic climax plant community. This, however, is not able to be reached in the succession in those parts affected by salt-spray-bearing winds. In such situations, the communities vary from those dominated by low herbs and dwarf shrubs to *Mimusops caffra* Transitional Forest. Except where there is disturbance, these are regarded as climax communities dependent mainly upon the degree of exposure to salt-spray, or wave-splash, although edaphic factors are also important.

Elsewhere edaphic factors are of prime importance; those interrelated factors which affect the water-holding capacity and the height of the water-table are considered to have the greater significance. This is reflected in the differences in the plant communities and the plant succession in those different situations where the texture of the soil, the aspect and the altitude vary. Succession is dependent largely upon an improvement to edaphic conditions. This may involve geological time such as in the weathering of the porous white, relatively modern, sands to those having a higher clay content. An increase in the organic content of the soil or a raising of the water-table helps to overcome the lack of clay in these soils. However, in spite of organic improvement, the most advanced community that is able to be supported by the porous white sands of the Isipingo North dunes is Dune Forest, a climax community which lacks several of the more mesophytic components of Coast Forest. These dunes, being relatively isolated, do not have the advantage of soil-water seepage from places further afield. The vegetation is therefore dependent upon local precipitation for its main supply of water.

In the lower-lying parts altitude and drainage are particularly important, especially in tidally affected parts, since these govern the degree and duration of submergence by saline or brackish waters and the height of the water-table. The rate of accretion and texture of material deposited is thus of considerable significance to plant succession. Mangroves eventually dominate the estuarine intertidal communities. Above this level, where drainage permits, succession later leads to Coast Forest.

Throughout the study area, but less so on the very steep slopes, man has had a profound influence on the vegetation. This has been due mainly to cutting, clearing or burning of existing vegetation and to his having changed the topography, soil types and local drainage.

In addition to the destruction or damage to individual plants, the action of herbalists, picnickers or other visitors to seaward communities often has a more widespread effect. This is due to the removal of cover allowing wind to drive sand or carry salt-spray into formerly protected parts, with deleterious effects to the vegetation.

It is considered that the most widespread disturbance of longest duration has been due to fire. The effect of fire has been to encourage grass-dominated communities at the expense of hygrophilous or mesophytic trees. This has been effected by halting succession or through retrogression from more advanced communities.

Apart from environmental degradation on unstable soils following disturbance, in the mesic parts, in particular, many naturalized aliens have been able to become established as a result of disturbance.

With the spread of *Lantana camara* in recent decades the pattern of succession has altered. The vigorous growth of this species in open communities has accelerated the establishment of shade-tolerant, or shade-dependent, forest precursors and initials (mostly animal distributed) and has adversely affected the establishment of heliophilous herbs, shrubs or trees.

Where there is protection from fire or other forms of disturbance, succession is actively proceeding towards Coast Forest in all mesic parts. On the steeper slopes relic communities occur which are treated here as lociations of Coast Forest.

The various plant communities and their interrelations, correlated with the main environmental factors, are discussed in Chapter 4. The abiotic environmental factors are discussed more or less individually in Chapters 1 and 2. Biotic factors are included in Chapter 5 and a historical outline, illustrating the effect of man in the study area, is given in Chapter 3. In addition, an annotated check-list of the vascular plants collected in the study area is included in Chapter 6. Photographs, line drawings, schematic diagrams of suggested community interrelations and tables are included to illustrate features discussed.

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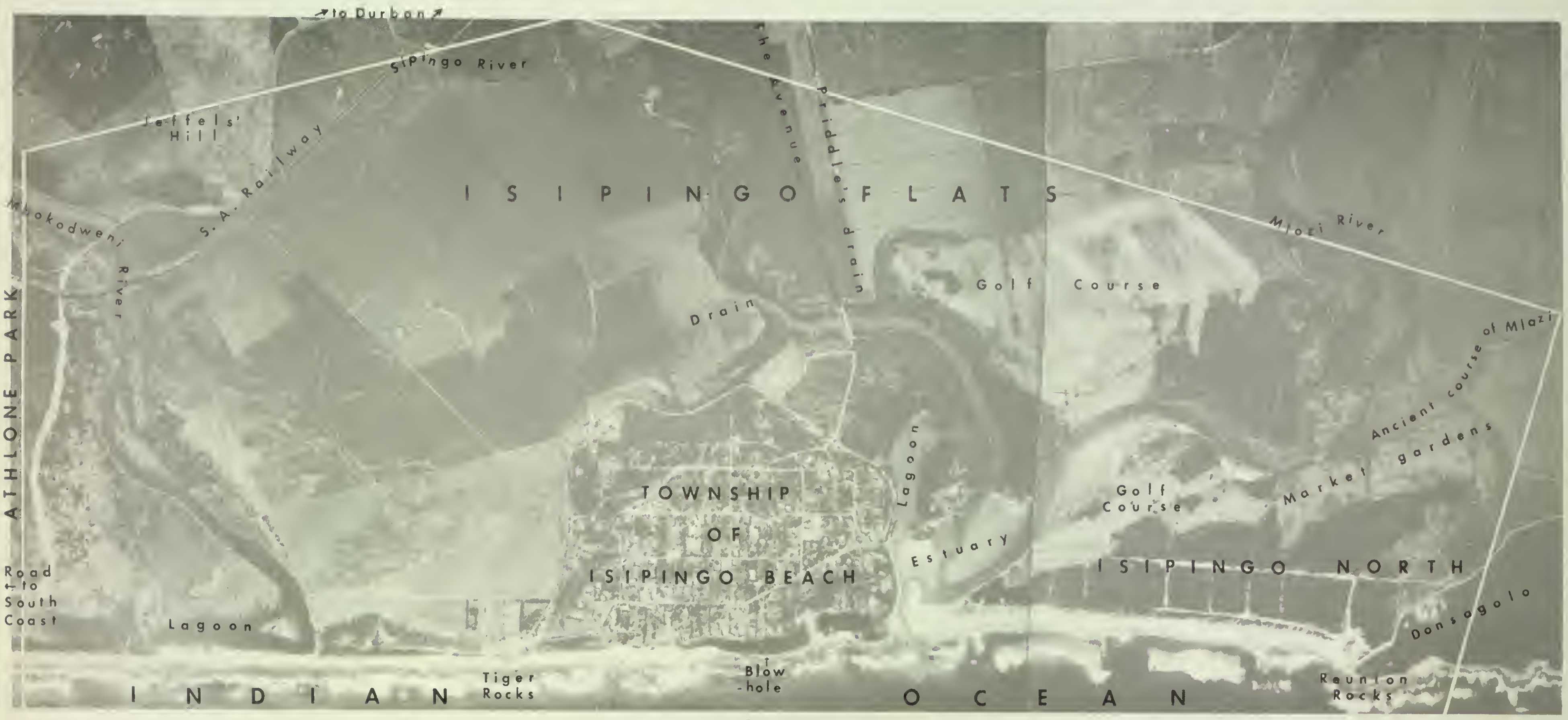
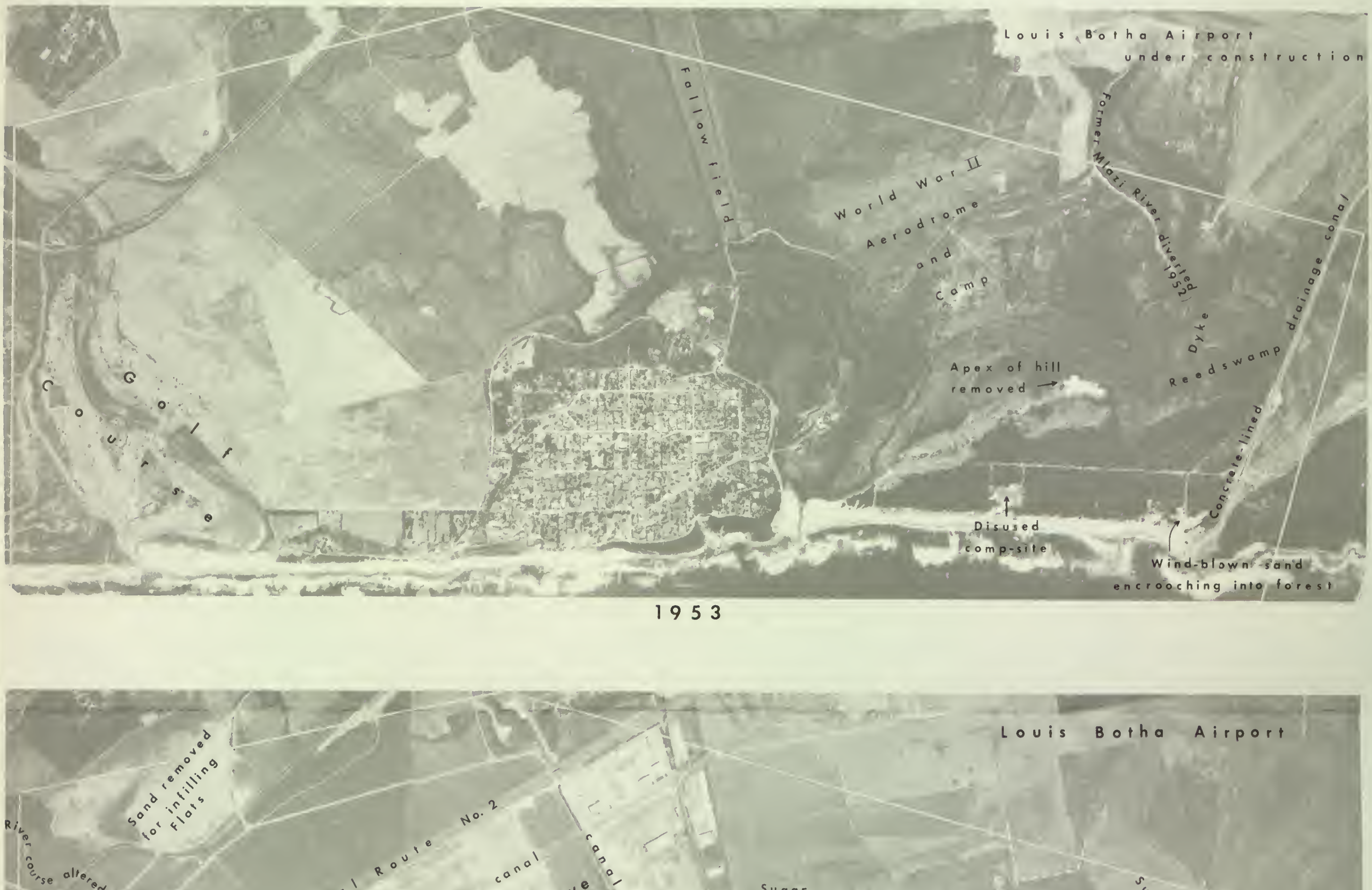
~~Author~~: Area, Natal, S.A. C.J.Ward.
Accession no.: Nursery Call no.:

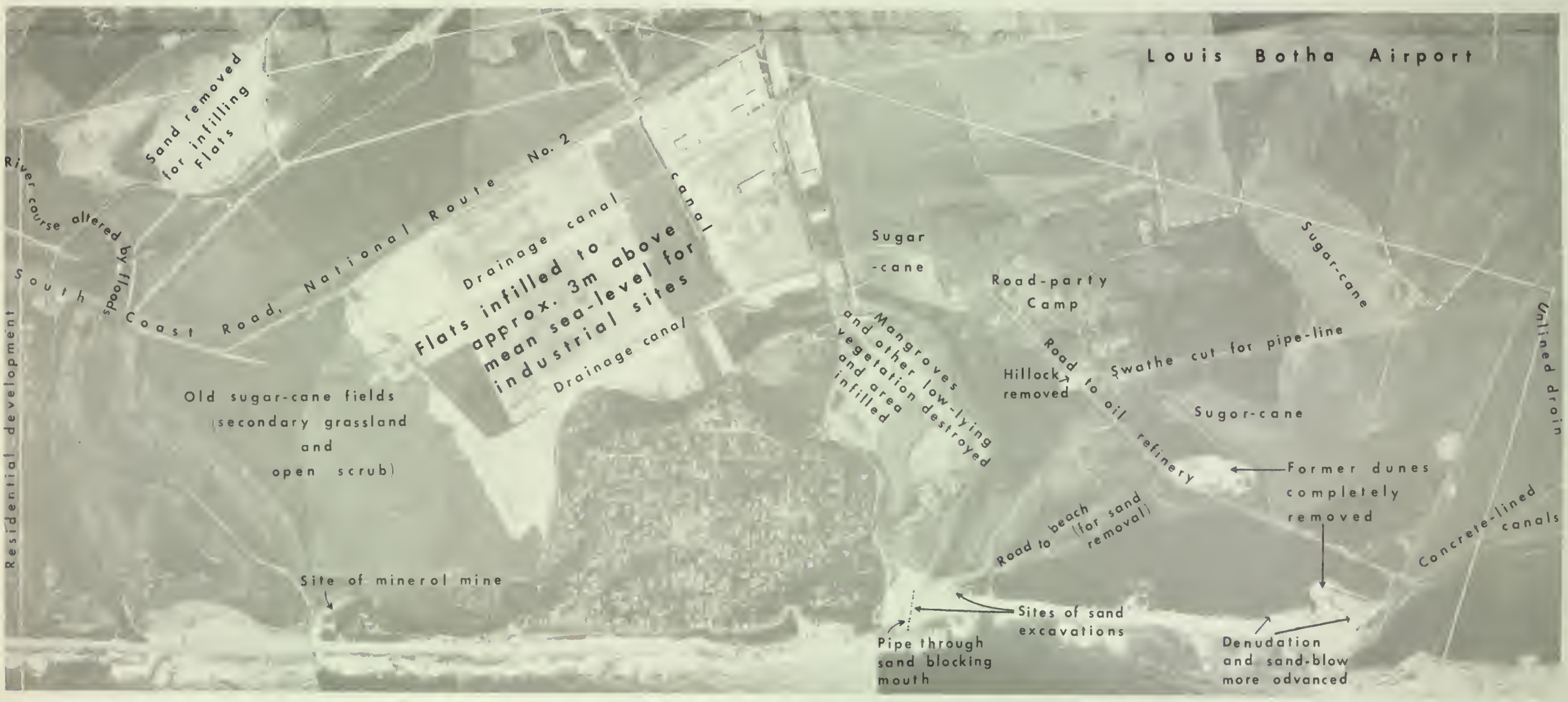
Date out	NAME	Date back



1937

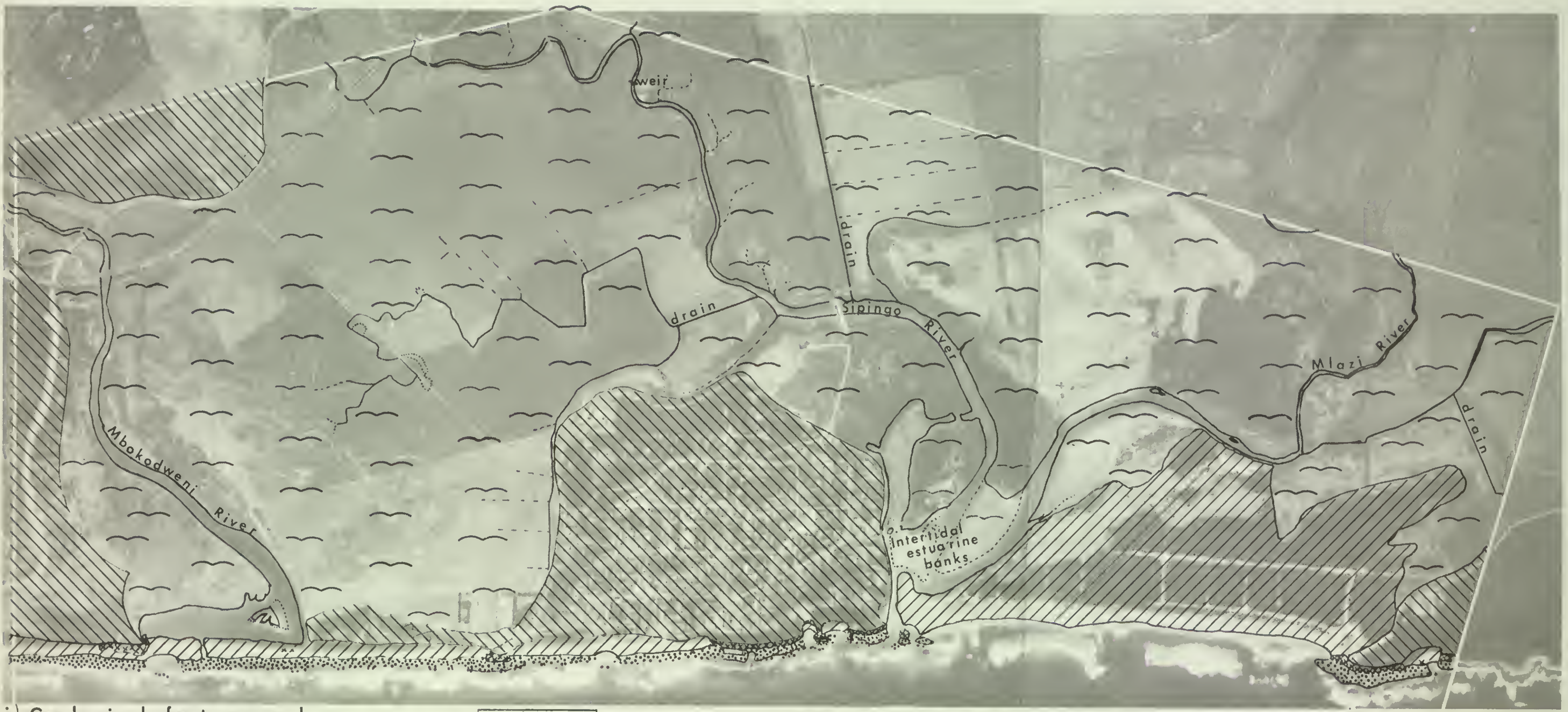

Louis Botha Airport under construction
Fallow field
Former Mlazi River diverted 1952
World War II Aerodrome and Camp
Golf Course
Dyke
Reedswamp drainage canal
Apex of hill removed
Concrete-lined
Disused comp-site
Wind-blown sand encroaching into forest

1953


Louis Botha Airport
Sand removed for infilling Flats
River course altered by floods
National Route No. 2
Drainage canal
canal
South Coast Road,
Flats infilled to approx. 3m above mean sea-level for industrial sites
Drainage canal
Sugar-cane
Road-party Camp
Sugar-cane
Residential development
Mangroves and other low-lying vegetation destroyed and area infilled
Hillock removed
Road to oil refinery
Swathe cut for pipe-line
Unlined drain
Old sugar-cane fields (secondary grassland and open scrub)
Sugar-cane
Former dunes completely removed
Road to beach (for sand removal)
Concrete-lined canals
Site of mineral mine
Sites of sand excavations
Pipe through sand blocking mouth
Denudation and sand-blow more advanced

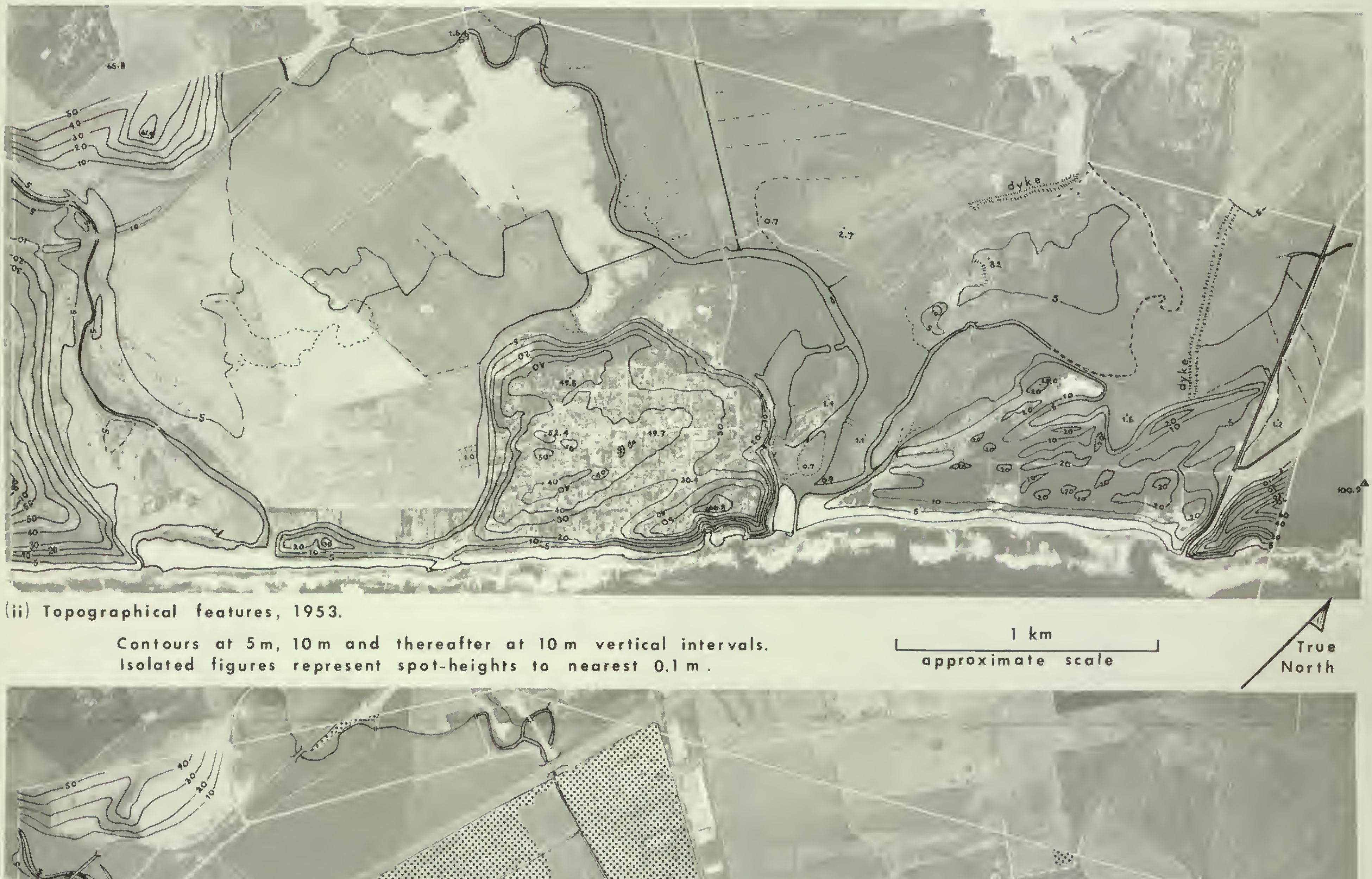
December, 1968

Fig. 3 Place names and major changes in the Isipingo Beach area, Natal, 1937 to 1968.
Study area bounded by white lines, broken lines representing portion of fenced boundary of Louis Botha Airport and shore-line. See also Fig. 2, Fig. 4 and, for further details of vegetation, Fig. 59.



(i) Geological features and drainage, 1937.

▨ Calcareous sandstone, intertidal
▨ " " , supralittoral
▨ Weathered Bluff Beds (red sands)
▨ Modern dunes (white sands)
▭ Alluvium

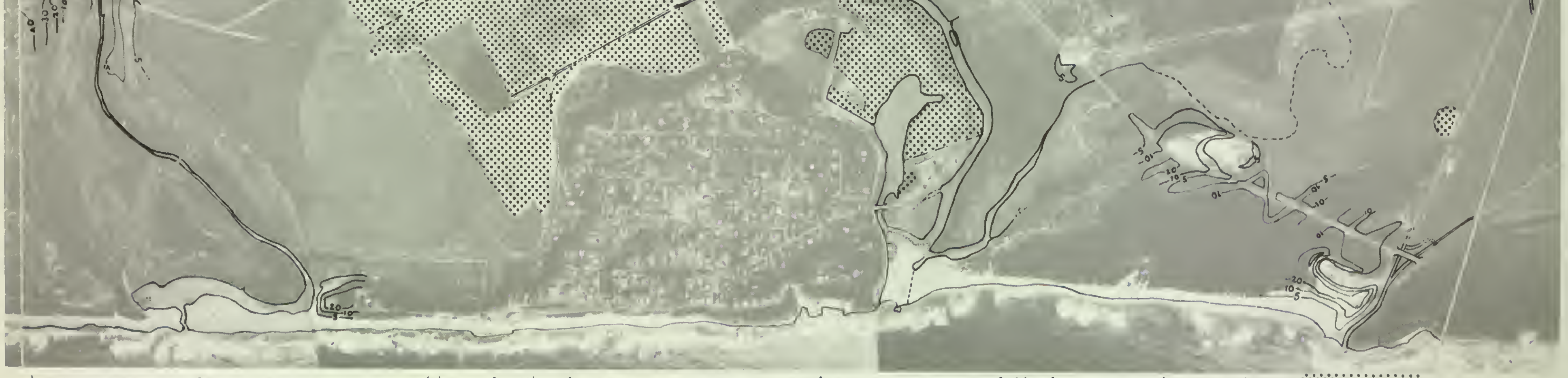


(ii) Topographical features, 1953.

Contours at 5 m, 10 m and thereafter at 10 m vertical intervals.
Isolated figures represent spot-heights to nearest 0.1 m.

1 km
approximate scale

True North



(iii) Changes in features shown in (i) and (ii) above, as at 9 December, 1968. Infilled parts shown thus: ▨

Fig. 4 Geological and topographical features of the Isipingo Beach area, Natal. Data superimposed on photographs shown in Figure 2; see also Figure 3.

Fig. 59 SKETCH MAP OF THE **ISIPINGO BEACH AREA** SHOWING THE DISTRIBUTION OF THE MAJOR PLANT COMMUNITIES AS IN DECEMBER, 1968.

(Based on an enlargement of the aerial photographs shown in Figure 2. For place names and topographical and geological features see Figures 2 and 3.)

REFERENCE
Roads
Motor tracks
Footpaths
Railways
Bridges
Rivers
Concrete-lined canals
Unlined canals and drains
Built-up areas and recently cleared, levelled or infilled parts
Isolated buildings
Ruins
Sand quarries (excluding Jeffels' Hill and beach excavations)
Open sand
Supralittoral rocks
Sugar-cane fields
Cultivated trees, avenues and large hedges
Sand dune pioneer and open dune scrub communities
Dwarf salt-spray communities
Halophilous herb communities
Marsh, reedswamp and *Phragmites australis* communities
Phragmites mauritianus riverain communities
Grassed banks, sports field and golf course (including mowed feral grassland communities forming "roughs")
Mesophytic grassland and grass—dominated ruderal communities
Open mesophytic scrub communities
Closed Dune Scrub
Closed maritime scrub communities
Closed scrub or thicket communities, excluding primary dune and maritime scrub communities
Mangrove communities
Hibiscus tiliaceus communities
Mesophytic woodland — early Coast Forest communities
Mimusops caffra Woodland
Mimusops caffra Transitional Forest, including closed relicts (mostly converted to woodland)
Dune Forest
Coast Forest (mainly dry slope lociations), including relicts
Isolated trees or thickets, too small for symbols
A○, ○B represent, respectively, the individual specimens of *Avicennia marina* and *Bruguiera gymnorrhiza* most distant from the mouth of the Sipingo River
Study area bounded by shoreline, heavy black line and broken line representing part of fenced boundary of Louis Botha Airport.
1000 m
500 m
0
1 km
Approximate Scale
True North
Jeffels' Hill
South Coast Railway
National Route No. 2
Main South Coast Road
Mbokodweni River
Sipingo River
ISIPINGO BEACH
INDIAN OCEAN

MEMOIRS OF THE BOTANICAL SURVEY OF SOUTH AFRICA
MEMOIRS VAN DIE BOTANIESE OPNAME VAN SUID-AFRIKA

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